(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 756 316 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
29.01.1997 Bulletin 1997/05

(51) Int Cl.6: H01L 21/00

(21) Application number: 96305154.5

(22) Date of filing: 12.07.1996

(84) Designated Contracting States:
DE GB IT

(30) Priority: 19.07.1995 JP 182921/95

(71) Applicant: HITACHI, LTD.
Chiyoda-ku, Tokyo 101 (JP)

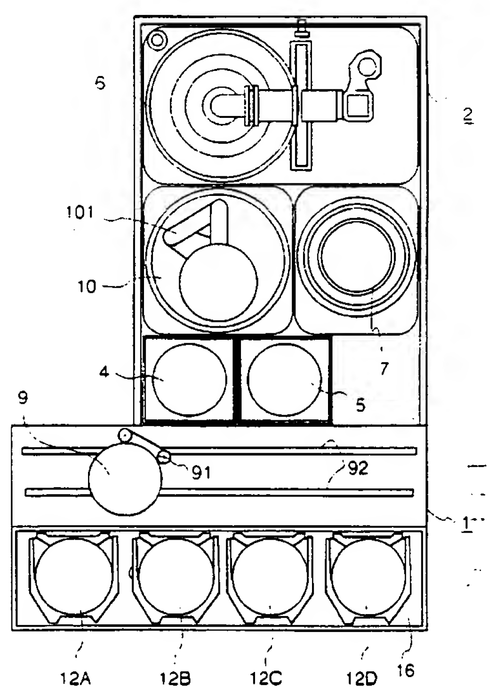
(72) Inventors:
- Soraoka, Minoru
Kumage-gun, Yamaguchi 745-06 (JP)
- Yoshioka, Ken
Hikari-shi, Yamaguchi 743 (JP)
- Kawasaki, Yoshinao
Kumage-gun, Yamaguchi 745-06 (JP)

(74) Representative: Paget, Hugh Charles Edward et al
MEWBURN ELLIS
York House
23 Kingsway
London WC2B 6HP (GB)

(54) **Vacuum processing apparatus and semiconductor manufacturing line using the same**

(57) A vacuum processing apparatus is composed of a cassette block (1) and a vacuum processing block (2). The cassette block has a cassette table for mounting a plurality of cassettes (12A. etc) containing a sample and an atmospheric transfer means (9). The vacuum processing block has a plurality of processing chambers (6.7) for performing vacuum processing to the sample and a vacuum transfer means (10) for transferring the sample Both of the plan views of the cassette block and the vacuum processing block are nearly rectangular. and the width of the cassette block is designed larger than the width of the vacuum processing block. and the plan view of the vacuum processing apparatus is formed in an L-shape or a T-shape.

FIG. 3



EP 0 756 316 A1

Description

Background of the Invention

Field of the Invention

The present invention relates to a vacuum processing apparatus, and particularly relates to a vacuum processing apparatus suitable for performing treatment such as etching, chemical vapor deposit (CVD), spattering, ashing, rinsing or the like of a sample of semiconductor substrate such as Si substrate and in a semiconductor manufacturing line for manufacturing semiconductor devices using the vacuum processing apparatus.

Description of the Related Art

Generally speaking, a vacuum processing apparatus is composed of a cassette block and a vacuum processing block. The cassette block has a front facing the bay path of the semiconductor manufacturing line and extending toward the longitudinal direction of the semiconductor manufacturing line, an alignment unit for aligning the orientation of a cassette for a sample or the orientation of a sample, and a robot operating under the atmospheric pressure environment. The vacuum block has a load lock chamber in the loading side, a load lock chamber in the unloading side, a processing chamber, a post treating chamber, a vacuum pump and a robot operating under a vacuum environment.

In the vacuum processing apparatus, a sample extracted from the cassette in the cassette block is transferred to the load lock chamber of the vacuum processing block by the atmospheric transfer robot. The sample is further transferred to the processing chamber from the load lock chamber by the atmospheric transfer robot and set on an electrode structure body to be performed processing such as plasma treatment. Then the sample is transferred to the post treating chamber to be processed, if necessary. The sample having been processed is transferred to the cassette in the cassette block by the vacuum transfer robot and the atmospheric transfer robot.

Vacuum processing apparatuses performing plasma etching to a sample are disclosed, for example, in Japanese Patent Publication No.61-8153, Japanese Patent Application Laid-Open No.63-133532, Japanese Patent Publication No.6-30369, Japanese Patent Application Laid-Open No.6-314729, Japanese Patent Application Laid-Open No.6-314730, and USP 5,314, 509.

In the above conventional vacuum processing apparatus, the processing chambers and the load lock chambers are concentrically arranged or arranged in rectangular shape. For example, in the apparatus disclosed in USP 5,314,509, a vacuum transfer robot is arranged near the center of the vacuum processing block and three processing chambers are concentrically arranged around the vacuum transfer robot, a load lock chamber in the loading side and a load lock chamber in the unload side are provided between the vacuum transfer robot and the cassette block. In these apparatuses, there is a problem in that required installation area of the whole apparatus is large since the rotating angles of the transfer arms of the atmospheric transfer robot and the vacuum transfer robot are large.

On the other hand, the processing chamber in the vacuum processing block and the vacuum pump and other various kind of piping components of the vacuum processing apparatus require maintenance such as scheduled and unscheduled inspection or repairing. Therefore, in general, there are provided doors around the vacuum processing block so that inspection and repairing of the load lock chamber, the un-load lock chamber, the processing chamber , the vacuum transfer robot and the various kind of piping components can be performed by opening the doors.

In the conventional vacuum processing apparatus, there is a problem in that the installation area is large even though the sample to be handled has a diameter d smaller than 8 inches (nearly 200 mm) and the outer size of the cassette C_w is nearly 250 mm. Further, for a case of handling a large diameter sample having a diameter d above 12 inches (nearly 300 mm), the size of the cassette C_w becomes nearly 350 mm. Accordingly, the width of the cassette block containing a plurality of cassettes becomes large. If a width of the vacuum processing block is determined based on the width of the cassette block, the whole vacuum processing apparatus requires a large installation area. Considering a cassette block containing four cassettes as an example, the width of the cassette block cannot help increasing at least by nearly 40 cm when the diameter d of a sample increases from 8 inches to 12 inches.

On the other hand, in a general semiconductor manufacturing line, in order to perform a large amount of samples and various kinds of processes, a plurality of vacuum processing apparatuses performing the same processing are gathered in a bay, and transmission between bays is performed automatically or manually. Since such a semiconductor manufacturing line requires a high cleanness, the whole semiconductor manufacturing line is installed in a large clean room. Increase in size of a vacuum processing apparatus due to increase in diameter of a sample to be processed results in increase in the installation area of the clean room, which further increases the construction cost of the clean room having a high construction cost in its nature. If vacuum processing apparatuses requiring a lager occupying installation area are installed in a clean room having the same area, it cannot help reducing total number of the vacuum processing apparatuses or decreasing in the spacing between the vacuum processing apparatuses. The reducing total number of the vacuum processing apparatuses in the clean room naving the same area decreases the productivity of the semicon-

ductor manufacturing line and increases the manufacturing cost of the semiconductor devices as an inevitable consequence. On the other hand, the decreasing in the spacing between the vacuum processing apparatuses decreases maintainability of the vacuum processing apparatus due to lack of maintenance space for inspection and repairing.

Summary of the Invention

An object of the present invention is to provide a vacuum processing apparatus capable of coping with larger diameter samples whilst keeping manufacturing cost to a minimum.

Another object of the present invention is to provide a vacuum processing apparatus capable of coping with larger diameter samples at the same time having better maintainability.

A further object of the present invention is to provide a semiconductor manufacturing line capable of coping with larger diameter samples whilst keeping manufacturing cost to a minimum by keeping the necessary number of vacuum processing apparatuses, through more economical use of space and at the same time not decreasing the maintainability.

The present invention provide a vacuum processing apparatus composed of a cassette block and a vacuum processing block, and the cassette block has a cassette table for mounting a cassette containing a sample, and the vacuum processing block has a processing chamber treating the sample and a vacuum transfer means for transferring the sample. In the vacuum processing apparatus, both of the plan views of said cassette block and said vacuum processing block are rectangular or approximately so and the relation W_1-W_2≥C_w is satisfied, where W_1 is the width of said cassette block, W_2 is the width of said vacuum processing block, and C_w is the width of one cassette.

Another aspect of the present invention is that the width of the cassette block is designed larger than the width of the vacuum processing block, and the plan view of the vacuum processing apparatus is formed in an L-shape or a T-shape.

A further aspect of the present invention is that a semiconductor manufacturing line comprises a plurality of bay areas having a plurality of vacuum processing apparatuses composed of a cassette block and a vacuum processing block are arranged in order of manufacturing process, and the cassette block has a cassette table for mounting a cassette containing a sample, and the vacuum processing block has a process chamber for performing vacuum processing to the sample and a vacuum transfer means for transferring the sample. In the semiconductor manufacturing line, at least one of the vacuum processing apparatuses is deigned so that the cassette block is capable of containing a sample having a diameter not less than 300 mm, and the relation W_1-W_2≥C_w is satisfied, where W_1 is the width of the cassette block, W_2 is the width of the vacuum processing block, and C_w is the width of one cassette.

A still further aspect of the present invention is a method of constructing a semiconductor manufacturing line which comprises a plurality of vacuum processing apparatuses composed of a cassette block capable of containing a sample having a diameter not less than 300 mm, and a vacuum processing block for performing vacuum processing to said sample. In the method of constructing a semiconductor manufacturing line at least one of the vacuum processing apparatuses is designed so that the width of the cassette block is larger than the width of the vacuum processing block and the plane view of the vacuum processing apparatus is formed in an L-shape or a T-shape, and a maintenance space is provided between the L-shaped or the T-shaped vacuum processing apparatuses and the adjacent vacuum processing apparatus.

According to the present invention, the plan shapes of the cassette block and the vacuum processing block are rectangular, and the cassette block and the vacuum processing block are designed so that the relation $W_1>W_2$ is satisfied where W_1 is the width of the cassette block and W_2 is the width of the vacuum processing block. Thereby, the plan view of the whole of the vacuum processing apparatus becomes L-shaped or T-shaped. In a case of arranging many such vacuum processing apparatuses, a sufficient space can be provided between the vacuum processing blocks adjacent to each other even if the interval between the vacuum processing blocks adjacent to each other is made small. For example, when W_1 is 1.5 m and W_2 is 0.8 m, a maintenance space of 0.7 m can be provided between the vacuum processing apparatuses adjacent to each other.

Therefore, in spite of a larger diameter sample, the number of vacuum processing apparatuses installed in a clean room having the same area as a conventional clean room, does not need to be reduced. Accordingly productivity of the semiconductor manufacturing line does not decrease. Thus, it is possible to provide a vacuum processing apparatus which can cope with a larger diameter sample and, at the same time, can suppress increase in the manufacturing cost, and has better maintainability.

Further, by employing the vacuum processing apparatus according to the present invention in a semiconductor manufacturing line, it is possible to provide the semiconductor manufacturing line which can cope with a larger diameter sample whilst keeping manufacturing cost to a minimum by keeping the necessary number of processing apparatuses, through more economical use of space and at the same time not decreasing the ease of maintainance.

Brief Description of the Drawings

FIG.1 is a outer perspective view showing an embodiment of a vacuum processing apparatus in accord-

ance with the present invention.

FIG.2 is a vertical cross-sectional view showing the main portion of the apparatus of FIG.1.

FIG.3 is a view showing the plan construction of the vacuum processing apparatus being taken on the plane of the line III-III of FIG.2.

FIG.4 is a cross-sectional view showing the apparatus being taken on the plane of the line IV-IV of FIG.2.

FIG.5 is a plan view showing an embodiment of a bay area of a semiconductor manufacturing line having a vacuum processing apparatus in accordance with the present invention.

FIG.6 is a view showing a part of a sample flow in an embodiment of a semiconductor manufacturing line in accordance with the present invention.

FIG.7 is a view showing the relationship between the size of a vacuum processing block and the size of a cassette block.

FIG.8 is a view explaining maintenance of a vacuum block of a vacuum processing apparatus in accordance with the present invention.

FIG.9 is a plan view showing the construction of an example of a conventional vacuum processing apparatus.

FIG.10 is a view showing an example of the relative relationship of various kinds of elements inside a vacuum processing apparatus in accordance with the present invention.

FIG.11 is a view showing a plan construction of another embodiment of a vacuum processing apparatus in accordance with the present invention.

FIG.12 is a perspective view showing the vacuum processing apparatus of FIG.11.

FIG.13 is a view showing a plan construction of another embodiment of a vacuum processing apparatus in accordance with the present invention.

FIG.14 is a view showing a plan construction of another embodiment of a vacuum processing apparatus in accordance with the present invention.

FIG.15 is a view showing a plan construction of another embodiment of a vacuum processing apparatus in accordance with the present invention.

FIG.16 is a plan view showing anther embodiment of a bay area in accordance with the present invention.

FIG.17 is a plan view showing anther embodiment of a bay area in accordance with the present invention.

FIG.18 is a plan view showing the construction of an embodiment of a semiconductor manufacturing line in accordance with the present invention.

FIG.19 is a plan view showing the construction of an embodiment of a semiconductor manufacturing line in accordance with the present invention.

FIG.20 is a plan view showing the construction of an embodiment of a semiconductor manufacturing line in accordance with the present invention.

FIG.21 is a view showing the plan structure of another embodiment of a vacuum processing apparatus in accordance with the present invention.

FIG.22 is a view showing the plan structure of another embodiment of a vacuum processing apparatus in accordance with the present invention.

Detailed Description of the Preferred Embodiments

An embodiment of a vacuum processing apparatus in accordance with the present invention will be described in detail below, referring to FIG.1 to FIG.4. As shown in FIG.1, each of vacuum processing apparatuses 100 is composed of a rectangular block shaped cassette block 1 and a rectangular block shaped vacuum processing block 2. Each of the plan shapes of the cassette block 1 and the vacuum processing block 2 is rectangular, and the whole plan shape formed by the both is L-shaped. The cassette block 1 faces a bay path of a semiconductor manufacturing line and extends in the lateral direction of the bay path, and in the front side of the cassette block there are a cassette table 16 for receiving and sending a cassette 12 containing a sample from and to the bay path and an operation panel 14. The vacuum processing block 2 installed in the back side of the cassette block 1 extends in the direction perpendicular to the cassette block 1 and contains various kinds of devices for performing vacuum processing and a transfer device.

As shown in FIG.2 to FIG.4, in the cassette block 1 there are provided an atmospheric robot 9 for transferring the sample and cassettes 12 for holding the sample. The sample cassettes 12 are product sample cassettes 12A, 12B, 12C and a dummy sample cassette 12D. An orientation adjuster for the sample may be provided near the cassettes 12, if necessary. The cassette 12 contains only product samples or product and dummy samples. Samples for checking foreign substance and/or for cleaning are contained in the uppermost stage and/or the lowermost stage of the cassette.

In the vacuum processing block 2, there are provided a load side load lock chamber 4, an unload side load lock chamber 5, a processing chamber 6, a post treating chamber 7, a vacuum pump 8 and a vacuum transfer robot 10. The reference character 13 is a discharging means for etching, and the reference character 14 is a discharging means for post treating (ashing).

The atmospheric transfer robot 9 is movably installed on a rail 92 placed parallel to the cassette table 16 inside the cassette block 1 to transfer a sample 3 the cassette 12 and the load lock chamber 4 in the load side and the load lock chamber 5 in the unload side. The vacuum transfer robot 10 transfers the sample 3 from the load lock 5 in the load side to the processing chamber 6 and also transfers the sample 3 among the processing chamber 6, the load lock chamber 5 in the unload side and the post treating chamber 7. The present invention is based on handling of a larger diameter sample having a diameter d above 12 inches (nearly 300 mm). When the diameter of the sample is 12 inches, the outer size C_w of the cassette is nearly 350 mm to 360 mm.

The processing chamber 6 processes the sample 3 one-by-one, and is. for example. a chamber for performing plasma etching. and placed in the upper left of the vacuum processing block 2. The load lock chamber 4 in the load side and the load lock chamber 5 in the unload side are placed in the opposite side of the processing chamber 6 across the vacuum transfer robot 10 each other. that is. the both are placed in the lower position of the vacuum processing block 2. The post treating chamber 7 is a chamber for perform post treating to the processed sample 3 one-by-one, and placed in the middle position of the vacuum processing block 2 in facing the load lock chamber 5 in the unload side.

The atmospheric transfer robot 9 has an extensible arm 91 which is so designed that the locus of the extensible arm extending and contracting while the robot is moving on the rail 92 becomes the locus containing the cassette 12 in the loader and the load lock chamber 4 in the load side and the load lock chamber 5 in the unload side. The vacuum transfer robot 10 has an extensible arm 101 which is so designed that the rotating locus of the extensible arm becomes the locus containing the load lock chamber 4 in the load side and the processing chamber 6, and is placed in the vacuum processing block 2. Therefore, the extensible arm 101 of the vacuum transfer robot is so installed that the rotating locus contains the processing chamber 6. the load lock chamber 5 in the unload side and the post treating chamber 7. The installed position of the atmospheric transfer robot 9 may be in the right side position on the cassette block 1.

A wafer search mechanism is provided around each of the cassettes 12 to recognize the samples in each of the cassettes when the cassette 12 is set. In the load lock chambers 4. 5 and the processing chamber 6 and the post treating chamber 7. there are provided sample lifting mechanisms 14A. 14B. respectively. so that the sample 3 can be transferred to the extensible arm 91 or 101 in each of the robots. Further, in the processing chamber 6. there are provided an electrode of an etching discharge means 13 and a sample mounting table 14C. Inside the etching discharge means 13. there is provided the sample lifting mechanism 14B. The reference character 15 is a ring-shaped gate valve.

Processing operation of a sample inside the processing chamber 100 will be described below. in taking plasma etching process as an example. Initially, the atmospheric transfer robot 9 in the cassette block 1 is moved on the rail 92 to approach to, for example, the cassette 12A in the load side, and a fork (not shown) is inserted under the sample 3 inside the cassette in the load side by extending the extensible arm 91 toward the cassette 12A to mount the sample 3 on the fork. After that. the arm 91 of the atmospheric transfer robot 9 is moved to the load lock chamber 4 in the load side while the cover of the load lock chamber 4 in the load side is kept open to transfer the sample 3. In this time, the atmospheric transfer robot 9 is moved on the rail 92 in such a manner that the stroke of the extensible arm 91 may reach the load lock chamber 4 in the load side. if necessary.

Then, the sample lifting mechanism 14A is operated to support the sample 3 on a support member of the load lock chamber 4 in the load side. Further. after evacuating the load lock chamber 4 in the load side to a vacuum. the support member is lowered and the sample lifting mechanism 14A is operated again to transfer the sample to the arm 101 of the vacuum transfer robot 10 and transfer the sample along the transfer path inside the processing chamber 2, that is, to the processing chamber 6 in the vacuum environment. By the reverse operation. the sample is transferred to a cassette position in the unload side in the cassette block 1.

In a case of requiring post treating, the sample is transferred to the post treating chamber 7 using the arm 101 of the vacuum transfer robot 10. In the post treating chamber 7, the sample having been performed etching processing is performed plasma post treating such as ashing.

In FIG.3. the locus of the arm 101 of the vacuum transfer robot 10 is as follows. in taking a case where the samples 3 are in the load lock chamber 4 in the load side. the processing chamber 6 and the post treating chamber 7 and no sample is in the load lock chamber 5 in the unload side. That is. the arm 101 of the vacuum transfer robot 10 is initially transfers the one sample 3 in the post treating chamber 7 to the load lock chamber 5 in the unload side, and the sample 3 in the proceessing chamber 6 is transferred to the post treating chamber 7. Next. the sample 3 in the load lock chamber 4 in the load side is transferred to the vacuum chamber 6. Further. the sample 3 in the treating chamber 6 is transferred to the post treating chamber 7. The arm 101 repeats to trace the same locus

Since the vacuum transfer robot 10 is placed near the side end of the vacuum processing block 2. a worker can inspect and repair the vacuum transfer robot with easy posture. and accordingly maintenance can be easily performed.

FIG.5 is a plan view showing an embodiment of a bay area 200 of a semiconductor manufacturing line having a vacuum processing apparatus 100 in accordance with the present invention. In the figure, many L-shaped vacuum processing apparatuses 100 are arranged in spacing a maintenance space 203 having a gap G1, and a partition 120 divides the room into a high clean level room 201A and a low clean level room 201B. An automatic transfer machine 202 for supplying and transferring samples 3 is installed along the front surface of the cassette blocks 1 arranged in the high clean level room 201A. On the other hand, many vacuum processing blocks 2 are arranged in the low clean level room 201B. and the interval between them is the maintenance space to be described later.

FIG.6 is a view showing a part of a flow of a sample 3 in an embodiment of a semiconductor manufacturing

line in accordance with the present invention. At the entrance portion of each of the bay areas 200, there are provided an inspection apparatus 206 and a bay stoker 208. The back portion of each of the bay areas 200 communicates to a maintenance path 210, and there is provided an air shower 212 in the entrance of the maintenance path 210. The sample 3 supplied to the bay stoker 208 from the external is successively transferred to an in-bay automatic transfer machine 202 in a certain bay area 200 corresponding to the manufacturing process using a line automatic transfer machine 204, as shown by arrows. Further, the sample 3 is transferred from the in-bay automatic transfer machine 202 to the cassette block of the vacuum processing apparatus 100. In the vacuum processing apparatus 100, the sample 3 is transferred between the cassette block 1 and the vacuum processing block 2 by the atmospheric transfer robot 9 and the vacuum transfer robot 10. The sample 3 having processed in the vacuum processing block 2 is transferred to the in-bay automatic transfer machine 202, and further transferred to the line automatic transfer machine 204, and then transferred to the next bay area 200.

In a semiconductor manufacturing line having an in-bay automatic transfer machine, the in-bay automatic transfer machine 202 supplies a new sample (unprocessed wafer) to the cassette block 1 in each of the vacuum processing apparatuses 100 from the bay stoker 208 provided in each of the bays 200, and recovers a cassette containing a processed sample from the cassette block 1.

Corresponding to a requiring signal output from each of the vacuum processing apparatuses 100, the in-bay automatic transfer machine 202 receives a cassette containing a new sample (unprocessed wafer) from the bay stoker 208 provided in each of the bays 200, and runs up to and stops at a cassette position where the cassette block 1 of the vacuum processing apparatus outputs the requiring signal.

As a cassette handling robot installed in the in-bay automatic transfer machine 202, a robot having three-axis control function of rotating operation (θ-axis), vertical movement (Z-axis) and grip operation (ϕ-axis), or four-axis control function of rotating operation (θ-axis), vertical movement (Z-axis), grip operation (ϕ-axis) and back-and-forth movement (Y-axis) is used.

In a case where a processed cassette 12 has existed at a designated position in the cassette block 1, according to the required content output from each of the vacuum processing apparatuses 100 the cassette handling robot recovers the cassette 12 from the cassette block 1 to an empty cassette store on th in-bay automatic transfer machine 202, and then supplies a new cassette 12 transferred from the bay stoker 208 to the position made empty by recovering.

After completion of this operation, the in-bay automatic transfer machine transfers the recovered cassette 12 to the bay stoker 208, and stops its operation and stands by until the next requiring signal is output from the vacuum processing apparatus 100 in the bay 200.

When requiring signals are output from plural vacuum processing apparatuses 100, 100, ... in the bay 200 within a short time, it depends on the system design whether the in-bay automatic transfer machine transfers samples according to order of time sequence of the received signals, or according to order of higher transfer efficiency from the stand-by position of the in-bay automatic transfer machine 202 in taking account of the relationship between the time difference in receiving signals and the positions of signal output apparatuses.

Cassette management is performed in such a manner that information on a received and sent cassette includes a number specified each of cassettes and various kinds of information used in managing the total manufacturing line, and is transmitted between the vacuum processing apparatus 100 and the in-bay automatic transfer machine 202 via, for example, an optical communication system.

Processing flow in the bay area 200 will be described below, in taking a sample in each cassette into consideration.

In the cassette block 1, three to four cassettes 11, 12 are placed side by side on a plane in the same level. In each of the cassettes, a given number of samples, in this case, semiconductor element substrates (wafers) having a diameter of 300 mm (12") are contained.

In the two to three cassettes 12 among the three to four cassettes 12, samples to be performed certain vacuum processing in the vacuum processing portion (unprocessed wafers) are contained. In the remaining one cassette 11, dummy wafers are contained.

The dummy wafer is used for checking number of foreign particles in the vacuum processing portion and/or cleaning process of the processing chamber composing the vacuum processing zone.

Here, letting the cassettes 12 containing samples before processing be called as 12A, 12B, 12C In such a state, a containing state of samples of, for example, the cassette 12A is checked by a wafer check means (not shown). IN this case, the cassette 12A has a function to store samples in vertical direction one-by-one.

As the wafer check means used, there are a means where a sensor is successively moved so as to correspond to sample containing stages of the cassette 12A, and a means where plural sensors are provided corresponding to respective sample containing stages of the cassette 12A. In such a means, there is no need to provide a means for moving so as to correspond to sample containing stages of the cassette 12A. It may be possible to fix the sensor for wafer check means and move the cassette 12A instead.

Using the wafer check means, it is checked in which positions in the vertical direction of the cassette 12A the unprocessed samples are contained. For example, in a case where the wafer check means is the type in which a sensor is successively moved so as to correspond to sample containing stages of the cassette 12A, the sen-

sor detects a sample containing stage of the cassette 12A and presence or absence of a unprocessed sample in the containing stage while the sensor is moving, for example, upward from the lower position of the cassette 12A. or downward from the upper position of the cassette 12A.

The check results are output from the wafer check means to be input to and stored in, for example, a host computer (not shown in the figure) of the semiconductor manufacturing line control for managing the whole vacuum processing apparatuses. Otherwise, the check results may be input to and stored in a personal computer in a console box on the cassette mounting table or the host computer for controlling the apparatuses through the personal computer.

Then, in this embodiment, the atmospheric transfer robot 9 is started to operate. By operation of the atmospheric transfer robot 9, one of the unprocessed samples in the cassette 12A is extracted out of the cassette 12A.

The atmospheric transfer robot 9 has a scooping-up device for scooping up and holding the surface of a sample opposite (reverse) to the surface to be processed. The scooping-up devices used are a device adhering and holding the reverse side surface of the sample. a device having grooves or indented portions for holding the sample, and a device mechanically gripping the peripheral portion of the sample. Further, as the device adhering and holding the reverse side surface of the sample, there are devices having a function of vacuum sucking adhesion and a function of electrostatic attraction.

In a case of using the device adhering and holding the reverse side surface of the sample having a diameter of 300 mm (12"). it is important to select the arrangement and the dimension of the adhering portion so as to decrease bending of the sample as small as possible. For example. interval between the adhering portions is set to d/3 to d/2 taking the center of the sample as the center where d is the diameter of the sample.

Depending on the amount of bending and the feature of bending of the sample. displacement of the sample occurs when the sample is transferred between the scooping-up device and another transfer means. which sometimes causes a trouble in displacement of the orientation of the sample.

Further, in a case of using the device adhering and holding the reverse side surface of the sample. the adhering force is required to have such a strength that the sample is not detached by the inertia force acting on the sample when the sample is being transferred including starting and stopping time. If this condition is not satisfied, a trouble occurs in falling of the sample from the scooping-up device or in displacement of the orientation of the sample.

The scooping-up device is inserted in a position corresponding to the reverse surface of an unprocessed sample required to be extracted in the cassette 12A. In a state there the scooping-up device is inserted, the cassette 12A is lowered by a given amount or the scooping-up device is lifted by a given amount. By lowering of the cassette 12A or lifting of the scooping-up device, the unprocessed sample is transferred to the scooping-up device while the sample is kept in a scooped state. The scooping-up device extracts the sample out of the cassette 12A in keeping the state. Thus, one of the unprocessed samples in the cassette 12A is extracted out of the cassette 12A>

As described above. for example. the host computer instructs and controls the atmospheric transfer robot 9 which unprocessed sample in the cassette 12A is extracted.

The information from which stage in the cassette 12A the unprocessed sample is extracted is successively stored in the host computer every extraction of the sample.

The atmospheric transfer robot 9 having one unprocessed sample in the scooping-up device.is moved to and stopped at a position where the sample can be loaded into the load lock chamber 4.

The load lock chamber 4 is isolated from a vacuum environment of the vacuum processing portion 2 and is in an atmospheric pressure state. The unprocessed sample held by the scooping-up device of the atmospheric transfer robot 9 is loaded into the load lock chamber 4 in such a state to be transferred to the load lock chamber 4 from the scooping-up device.

The atmospheric transfer robot 9 having transferred the unprocessed sample into the load lock chamber 4 is returned to a predetermined position in standing by the next operation.

The operation described above is instructed and controlled by. for example. the host computer.

The information from which stage in the cassette 12A the unprocessed sample loaded in the load lock chamber 4 is extracted is successively stored in the host computer every extraction of the sample.

The load lock chamber 4 having received the unprocessed sample is isolated from atmosphere and evacuated to vacuum. Then. the isolation to the processing chamber is released and the load lock chamber 4 is communicated with the processing chamber to be capable of transferring the unprocessed sample. Then, a predetermined vacuum processing is performed in the vacuum processing zone.

The sample having been performed vacuum processing (sample after processed) is transferred from the vacuum processing zone to the unload lock chamber 5 by a vacuum transfer robot to be loaded into the unload lock chamber 5.

The vacuum transfer robot has a scooping-up device similar to that in the atmospheric transfer robot 9. As the scooping-up device, the scooping devices similar to those of the atmospheric transfer robot 9 may be used except for the device having a function of vacuum adhesion.

After loading the processed sample. the unload lock

chamber 5 is isolated from the vacuum processing portion 2 and the pressure inside the unload lock chamber 5 is adjusted to atmospheric pressure.

The unload lock chamber 5 in which the inner pressure becomes atmospheric pressure is opened to atmosphere. Under such a state. the scooping-up device of the atmospheric transfer robot 9 is inserted to the unload lock chamber 5. and the processed sample is transferred to the scooping-up device.

The scooping-up device having received the processed sample transfers the sample out of the unload lock chamber 5. After that, the unload lock chamber 5 is isolated from atmosphere and evacuated to a vacuum to be prepared for loading of the next processed sample.

On the other hand, the atmospheric transfer robot 9 having the processed sample in the scooping-up device is moved to and stopped at a position where the processed sample can be returned into the cassette 12A.

Then, the scooping-up device having the processed sample is inserted into the cassette 12A in keeping the state. The host computer controls the inserting position so that the processed sample is returned to the position where the processed sample has been originally contained.

After inserting the scooping-up device having the processed sample. the cassette 12A is lifted or the scooping-up device is lowered.

By doing so. the processed sample is returned to and contained in the position where the processed sample has been originally contained.

Such operation is similarly performed to the remaining unprocessed samples in the cassette 12A and also to the unprocessed sample sin the cassettes 12B. 12C

That is. the unprocessed sample successively extracted from each of the cassettes one by one is. for example. numbered. The host computer. for example. stores information on that an unprocessed sample extracted from which stage in which cassette has what number.

Based on the information. movement of a sample. extraction of the sample from a cassette. performing of vacuum processing to the sample and returning of the sample to the cassette after vacuum processing, is managed and controlled.

In other words, the movement of a sample from being extracted to being returned to the original cassette, is performed according to the steps in the following order.

(1) checking of a containing position in a cassette.
(2) extraction of a sample in the cassette using an atmospheric transfer robot.
(3) loading of the sample into a load lock chamber using an atmospheric transfer robot.
(4) transferring of the sample from load lock chamber to a vacuum processing zone using a vacuum transfer robot.
(5) performing vacuum processing in the vacuum processing zone.
(6) transferring of the sample from the vacuum processing zone to an unload lock chamber using the vacuum transfer robot.
(7) unloading of the sample from the unload lock chamber using the atmospheric transfer robot.
(8) containing of the sample into the original position in the cassette using the atmospheric transfer robot.

In every movement of the sample from (1) to (8) as shown in the above, the host computer successively updates the information on what designated number sample each of the stations has. The updating processing is performed for every one of the samples. By doing so, each of the samples is managed, that is, it is managed what designated number sample exists in which station.

For example, the successive updating state process by the host computer may be successively displayed on a vacuum processing system control CRT screen. In this case. each of the stations and what designated number sample exists at present are displayed so as to be easily recognized by an operator.

In a case where orientation adjustment of an unprocessed sample is performed. this step is performed between the above steps (2) and (3).

Such management and control for movement of samples may be performed in a case where the vacuum processing portion 2 has a plurality of vacuum processing zones.

Assuming that the vacuum processing portion 2 has. for example, two vacuum processing zones. In this case. the sample is processed in series or processed in parallel depending on the processing information. Here. the series processing means that. a sample is vacuum-processed in one vacuum processing zone. and the processed sample is successively vacuum-processed in the remaining vacuum processing zone. The parallel processing means that a sample is vacuum-processed in one vacuum processing zone. and another sample is vacuum-processed in the remaining vacuum processing zone.

In a case of series processing, a sample numbered by the host computer is processed according to a determined order and the processed sample is returned to the original position in the cassette.

In a case of parallel processing, since the host computer manages and controls in what vacuum processing zone and how a numbered sample is processed. the processed sample is returned to the original position in the cassette.

In a case of parallel processing, the host computer may manage and control which vacuum processing zone is used depending on from which stage in the cassette the sample is extracted and what designated number the sample has.

In a case where series processing and parallel processing are mixed, since the host computer manag-

es and controls in what vacuum processing zone and how a numbered sample is processed. the processed sample is returned to the original position in the cassette.

Examples of the plural vacuum processing zones are a combination of zones having the same plasma generating method. a combination of different plasma etching zones. a combination of a plasma etching zone and a post-processing zone such as ashing, a combination of an etching zone and a film forming zone and so on.

The dummy sample in a cassette is handled in the same manner as for the unprocessed sample except for performing vacuum processing which is performed to the unprocessed sample.

A detecting means for detecting presence or absence of a sample is provided in each of the cassette, the scooping-up device of the atmospheric transfer robot. the orientation adjusting station, the station in the load lock chamber, the scooping-up device of the vacuum transfer robot. the station in the vacuum processing zone, the station in the unload lock chamber.

A contact type or a non-contact type sensor is properly selected to be used as the sample detecting means.

The cassette. the scooping-up device and each of the stations become checking points for movement process of the sample.

In such a construction, for example, when presence of a sample is detected in the scooping-up device of the vacuum transfer robot 10 and presence of a sample is not detected in the station in the vacuum processing zone. this means that a trouble occurs in the sample transfer machine between the scooping-up device of the vacuum transfer robot and the station in the vacuum processing zone due to some cause. and recovering for the trouble can be properly and speedy preformed Therefore. it is possible to prevent the through-put of the whole system from decreasing.

In a construction where the sample detecting means is not provided in each of the scooping-up devices of the transfer robots 9. for example. when presence of a sample is detected in the station in the load lock chamber and presence of a sample is not detected in the station in the vacuum processing zone, this means that a trouble occurs in the sample transfer machine between the station in the load lock chamber and the scooping-up device of the vacuum transfer robot, or in the vacuum transfer robot. or the sample transfer machine between the scooping-up device of the vacuum transfer robot and the station in the vacuum processing zone due to some cause, and recovering for the trouble can be properly and speedy preformed. Therefore, it is possible to prevent the through-put of the whole system from decreasing.

Such an embodiment has the following usefulness.

(1) Since which stage in the cassette an unprocessed sample is contained is checked and movement of the checked unprocessed sample is successively managed and controlled by numbering the unprocessed sample. the processed sample can be certainly returned to the original position of the cassette.

(2) Since which stage in the cassette an unprocessed sample is contained is checked and movement of the checked unprocessed sample is successively managed and controlled by numbering the unprocessed sample even in a case of series processing. parallel processing or mixed processing of the both. the processed sample can be certainly returned to the original position of the cassette.

(3) Since which stage in the cassette an unprocessed sample is contained is checked and movement of the checked unprocessed sample is successively managed and controlled by numbering the unprocessed sample. the processing state of the sample processed in the vacuum processing portion one by one can be properly checked and managed in detail.

For example, in a case where a defect occurs in the process of the sample. since a processing state for each of the samples including processing condition is managed. the processing state can be identified by the information which stage in what cassette the defective sample is contained in. Therefore. the cause of the defect occurrence can be known in a short time and accordingly the time required for the countermeasure can be shortened by the time shortened in identification of the processing state.

Although the description in the above embodiment is based on that the diameter of the sample is 300 mm (12"). the above usefulness is not limited to the diameter of the sample.

The maintenance will be described below.

As for maintenance of the vacuum processing apparatus 100 in accordance with the present invention. most of the maintenance of the cassette block 1 can be performed from the front side of the cassette block since the cassette block 1 faces the line of in-bay automatic transfer machine 202.

On the other hand. as for the maintenance of the vacuum processing block 2, an operator is required to enter the area placing the vacuum processing block 2 from the back side of each bay area through the maintenance path 203 or through the maintenance path 210.

FIG.7 is a view showing the relationship between the size of the vacuum processing block 2 and the size of the cassette block 1. When the longer side (width) of the vacuum processing block 2 is written by W1 and the shorter side is written by B1. and the longer side (width) of the cassette block 1 is written by W2 and the shorter side is written by B2, the relations $W1>B1$, $W2>B2$ are satisfied. It is preferable that the relation $W1-W2 \fallingdotseq d$ is satisfied where d is the diameter of the sample.

When the gap between the cassette blocks of the vacuum processing apparatuses adjacent to each other is written by G1 and the gap between the vacuum processing blocks adjacent to each other is written by G2 (referring to FIG.5), it is assumed that the relation G1<G2 is satisfied. Maintenance space between the vacuum processing apparatuses 100 adjacent to each other can be expressed by (W1+G1)-W2=MS. MS is a dimension required for maintenance work of an operator. In this case, it is preferable that the relation (W1+G1)-W2≒d is satisfied. Although the maintenance space 203 is an entrance for the operator, there are some cases where the space is not provided depending on the layout of the bay area 200. Even in such a case, an installation clearance G1 between the vacuum processing apparatuses adjacent to each other is required at minimum, but the installation clearance practically becomes a value near zero. In this case, W1-W2=MS becomes the maintenance space.

The side face of the vacuum processing block 2 of the vacuum processing apparatus 100 in accordance with the present invention is of opening type door structure. That is, two pairs of hinged doors 214, 216 are provided in the side face and the back face of the vacuum processing block 2.

In order to perform maintenance, it is required that (1) there are spaces from which an operator can check the devices and the pipes from back and front sides, (2) there are spaces to which the various kinds of devices and pipes, for example, the main chamber can be drawn, and (3) there are spaces in which the doors can be opened. Therefore, the maintenance space MS is preferably 90 to 120 cm.

According to the vacuum processing apparatus 100 in accordance with the present invention, an operator can easily access to the side face and the back face of the vacuum processing block 2. Further, by opening the doors 214, the load lock chamber 5, the post treating chamber 7, the vacuum transfer robot 10 and the various kinds of pipes and devices can be inspected and repaired. Furthermore, by opening the doors 216, the processing chamber 6 and the vacuum pump and the various kinds of pipes and devices can be inspected and repaired.

Since there is the maintenance space MS between the vacuum processing blocks 2, there is no obstacle in that the operator opens the doors 214 in the side to perform maintenance work. Further, there is provided an enough space in the back face side of the vacuum processing block 2 to open the doors 216 and perform maintenance work.

The plan shape of the vacuum processing apparatus 100 is L-shaped, as described before. On the other hand, in the conventional vacuum processing apparatus 800, the vacuum processing block and the cassette block are generally constructed together to form a rectangular shape in the whole, as shown in FIG.9. The rectangular shape is selected based on the shape of various kinds of elements installed in the vacuum processing apparatus and the mutual operational relationship among the various kinds of elements. In the general conventional vacuum processing apparatus, when the gap between the cassette blocks adjacent to each other is written by G1 and the gap between the vacuum processing blocks adjacent to each other is written by G2, there is the relation G1≥G2.

Since the conventional vacuum processing apparatus 800 deals with samples having a diameter d not larger than 8 inches, such a construction described above can be used. However, in an apparatus dealing with a sample having a diameter d as large as 12 inches, the outer dimension of the cassette 12 becomes larger and consequently the width W1 of the cassette block containing a plurality of the cassette 12 becomes larger. Since the width (W2≒W1) of the vacuum processing block is determined corresponding to the width W1, the whole of the vacuum processing apparatus 800 requires a larger space. Further, as the widths W1, W2 of the cassette block and the vacuum processing block become larger, the doors 214, 216 must be made larger and a large maintenance space is required inorder to keep a space for the doors 214, 216 to be opened. For example, if a 12-inch sample is dealt in the conventional apparatus, W1=W2=150 cm, G1=G2=90 cm and the maintenance space between the vacuum processing apparatuses 100 adjacent to each other becomes MS=90 cm. This results in increase in effective occupying area of the vacuum processing apparatus 800 in each of the bay areas. This is not preferable.

An embodiment of the mutual relationship of the various kinds of elements in the vacuum processing apparatus in accordance with the present invention will be described, referring to FIG.10. As shown in the figure the rotational center 01 of the arm of the vacuum transfer robot 10 is arranged in the right hand side or the left hand side of the line L-L connecting the middle position of the load lock chamber 4 and the unload lock chamber 5 and the center of the processing chamber 6, that is, the rotational center 01 is shifted toward the side end side of the vacuum processing portion. The post treating chamber 7 is arranged in the opposite side of the line L-L. Therefore, the rotating range of the arm of the vacuum transfer robot 10 is narrow, and the whole plan shape of the vacuum processing apparatus 100 can be made L-shaped by arranging the vacuum transfer robot 10 near the side end of the vacuum processing portion. By such a construction,the rotation range of the arm of the vacuum transfer robot 10 becomes nearly one-half of one round circle. By making the rotating range of the arm of the vacuum robot 10 for transfer a wafer to limit within nearly semi-circle, one sample 3 can be transferred to the load lock chamber 4, the unload lock chamber 5, the processing chamber 6 and the post treating chamber 7 within nearly semi-circle movement of the arm. As described above, since the rotating range of the arm of the vacuum transfer robot 10 is designed within nearly semi-

circle. the width W2 of the vacuum processing block 2 can be made narrow.

As described above, the vacuum processing apparatus 100 in accordance with the present invention keeps the aforementioned maintenance space by making the width W2 of the vacuum processing block 2 as small as possible in taking the shape of the various kinds of elements arranged in the vacuum processing apparatus and the mutual relationship of the various elements into consideration while the width W1 of the cassette block 1 copes with the large diameter sample. By doing so. the effective occupied area of the vacuum processing apparatus 100 can be increased.

Since there is the maintenance space MS between the vacuum processing blocks 2, there is no obstacle in that the operator opens the doors 214 in the side to perform maintenance work. Further, there is provided an enough space in the back face side of the vacuum processing block 2 to open the doors 216 and perform maintenance work.

In the vacuum processing apparatus 100 in accordance with the present invention, the positional relationship between the vacuum processing block 2 and the cassette block 1 can be changed along the lateral direction of the cassette block. For example. as shown in FIG. 11 and FIG.12. the vacuum processing block 2 and the cassette block 1 are arranged so that the center line of the vacuum processing block 2 cross in the center of the cassette block 1 in the lateral direction. in other words. the vacuum processing block 2 and the cassette block 1 may be arranged so as to form a T-shape in the whole plan shape. In the T-shape arrangement. since there is the maintenance space MS between the vacuum processing blocks 2. there is no obstacle in that the operator opens the doors 214 in the side to perform maintenance work

The plan shape of the cassette block 1 and the vacuum processing block 2 in accordance with the present invention may be not strictly rectangular. that is, nearly rectangular as far as the relation (W1+G1)-W2=MS is practically kept. The structural elements contained in the cassette block 1 and the vacuum processing block 2 and the arrangement relationship the structural elements may be different from those in the aforementioned embodiments. For example. in the embodiment shown in FIG.13, the atmospheric transfer robot 9 of the cassette block 1 is placed between the load lock chamber 4 and the unload lock chamber 5 of the vacuum processing block. In this case, the plan shape of the cassette block 1 is strictly projecting shaped and the plan shape of the vacuum processing block 2 is strictly depressing shaped, and the whole of the vacuum processing apparatus 100 is a combination of two blocks of nearly rectangular shape forming a T-shape. In this embodiment, the locus of the extensible arm 91 can be constructed so as to trace the locus containing the cassette 12 and the load lock chamber 4 in the load side and the load lock chamber 5 in the unload side 5 without moving of the atmospheric transfer robot 9 on the rail by placing the atmospheric transfer robot 9 of the cassette block 1 between the load lock chamber 4 and the unload lock chamber 5 of the vacuum processing block and movably arranging the cassette 12 on the rail 94. In this embodiment, the aforementioned maintenance space MS between the vacuum processing blocks 2 can be kept.

FIG.14 shows another embodiment of a vacuum processing apparatus 100 in accordance with the present invention. The vacuum processing apparatus has a cassette mounting table 130 and a console box 132 for evaluating and inspecting a sample in addition to a cassette block 1, an atmospheric transfer robot 9 and a sample cassette 12.

FIG.15 shows a further embodiment of a vacuum processing apparatus 100 in accordance with the present invention. The vacuum processing apparatus is a T-shaped vacuum processing apparatus having a cassette block 1, an atmospheric transfer robot 9 and a sample orientation adjuster 11.

FIG.16 is a plan view showing another embodiment of a bay area 200 in accordance with the present invention. A pair of L-shaped vacuum processing apparatuses 100A. 100B are arranged opposite to each other to form a set. and a console box 132 is placed between the sets. There is not the aforementioned gap G1. but (W1+W3)-W2=MS becomes the maintenance space when the width of the console box 132 is W3. Since there is no gap G1, an operator needs to enter the zone 201 placing the vacuum processing block 2 from the back of the bay area 200 through the maintenance path 210 in order to perform maintenance of the vacuum processing block 2. If it is required to reduce the access time. a gap G1 may be provided between the console box 132 and the neighboring cassette block 1 In this case (W1+W3+G1)-W2=MS becomes the maintenance space.

FIG 17 is a plan view showing a bay area having another embodiment of a vacuum processing apparatuses in accordance with the present invention. The vacuum processing apparatus 100 in this embodiment, cassette tables 16A for plural cassette blocks 1 are formed in a continuous one-piece structure, and a plurality of atmospheric transfer robots 9 run on a common rail 95 on the continuous cassette table. An in-bay automatic transfer machine is placed between the bar stoker and the atmospheric transfer robot 9 to transfer a sample between the vacuum processing blocks 2. In this case, the cassette block 1 is functionally corresponds to each of the vacuum processing blocks 2 one by one, and it can be thought that a plurality of nearly rectangular blocks corresponding to the respective vacuum processing blocks 2 are connected together.

FIG.18 is a plan view showing the construction of an embodiment of a manufacturing line in accordance with the present invention. It can be understood from FIG.18 that the vacuum processing apparatus 100 in accordance with the present invention is L-shaped or T-

shaped in plan shape and a sufficient maintenance space MS can be kept between the vacuum processing blocks 2 even if the gap between the vacuum processing apparatuses 100.

On the other hand, if the sufficient maintenance space is provided in the conventional rectangular vacuum processing apparatus 800 shown for the purpose of comparison, the gap between the vacuum processing apparatuses must be increased. As the result, number of vacuum processing apparatuses which can be arranged in the same length of line is only five for the conventional rectangular vacuum processing apparatus 800 in comparing to seven for the vacuum processing apparatus 100 in accordance with the present invention as shown in the embodiment. The difference of two in number of vacuum processing apparatuses is large when the whole semiconductor manufacturing line is considered, and becomes a large difference in arranging a necessary number of apparatus in a clean room having a given space and in saving footprint. As for transferring of sample from a bay area having an automatic transfer machine to a bay area for the next process, when the vacuum processing apparatus in accordance with the present invention is employed, an amount of processing corresponding to seven vacuum processing apparatuses can be performed using one side of the one bay area. Whereas, when the conventional apparatus is employed, an amount of processing corresponding to only five vacuum processing apparatuses can be performed. This difference of two apparatuses largely affects on improvement of through-put in a semiconductor manufacturing line.

There are some cases where the rectangular vacuum processing apparatus 800 is required to be partially used. Even in such a case, by arranging the L-shaped or T-shaped vacuum processing apparatus 100 in accordance with the present invention adjacent to the rectangular vacuum processing apparatus 800, a proper maintenance space MS can be kept between the vacuum processing blocks.

FIG.19 is a plan view showing the whole construction of another embodiment of a semiconductor manufacturing line in which the vacuum processing apparatuses in accordance with the present invention are partially employed. This semiconductor manufacturing line has a line automatic transfer machine 204 and is of a line automated type where transferring of a sample between each of the bay areas 200A to 200N and the line automatic transfer machine 204 is performed by an operator. In this system, the same effects as in the embodiment of FIG.18 can be attained.

FIG.20 is a plan view showing the whole construction of a further embodiment of a semiconductor manufacturing line in which the vacuum processing apparatuses in accordance with the present invention are partially employed. This semiconductor manufacturing line has in-bay automatic transfer machines 202 and a line automatic transfer machine 204 and is of a fully automated type where transferring of a sample inside each of the bat areas and between each of the bay areas 200A to 200N and the line automatic transfer machine 204 is performed without an operator. In this case, by arranging the L-shaped or T-shaped vacuum processing apparatuses 100 adjacent to each other or by arranging the L-shaped or T-shaped vacuum processing apparatus 100 in accordance with the present invention adjacent to the rectangular vacuum processing apparatus 800, a proper maintenance space MS can be kept between the vacuum processing blocks.

In the aforementioned embodiments, it has been described that the cassette and the atmospheric transfer robot are placed in an atmospheric environment and the atmospheric transfer robot is operated in an atmospheric environment. However, as shown in FIG.21 and FIG.22, it is possible that the cassette 12 is placed in a vacuum environment and the transfer robot 10 is operated in only a vacuum environment. FIG.21 shows an embodiment where two cassettes 12 are placed, and FIG.22 shows an embodiment where three cassettes 12 are placed. In the both cases, the whole vacuum processing apparatus is of a T-shape.

In FIG.21 and FIG.22, extraction of a sample in the cassette 12, transferring of the extracted sample to the vacuum processing zone, transferring of the sample from the vacuum processing zone and storing of the sample to the original position in the cassette are performed under a vacuum environment using the vacuum transfer robot 10. In these cases, in regard to the vacuum processing system, there is no need to provide the load lock chamber and the unload lock chamber in the aforementioned embodiments, in principle. Therefore, number of data elements successively updated by the host computer is reduced by number of the data elements used for the load lock chamber and the unload lock chamber.

In this case, a containing state of samples in the cassette is performed by a wafer check means under a vacuum environment. Further, in an apparatus having an orientation adjusting means of an unprocessed sample, the orientation adjustment is performed under a vacuum environment.

Furthermore, in an apparatus having an intermediate cassette between the cassette and the vacuum processing zone, there are provided a robot for transferring the sample between the cassette and the intermediate cassette and a robot for transferring the sample between the intermediate cassette and the vacuum processing zone.

In such a vacuum processing system, since the intermediate cassette is added, number of data elements successively updated by the host computer is increased by number of the data elements used for the intermediate cassette and the robot.

Still further, in the aforementioned embodiments, the processed surface of a sample is upside and the sample is held horizontal in a state when the sample is

contained in the cassette, in a state when the sample is transferred and in a state when the sample is vacuum-processed. However. the other position of the sample is no problem.

As having been described above, according to the present invention. it is possible to provide a vacuum processing apparatus capable of coping with larger diameter samples and capable of suppressing increase in manufacturing cost, and at the same time having a better maintainability.

Further, it is possible to provide a semiconductor manufacturing line capable of coping with larger diameter samples and at the same time capable of suppressing increase in manufacturing cost by maintaining necessary installation number of vacuum processing apparatuses and not decreasing the maintainability by employing the vacuum processing apparatuses in accordance with the present invention to the semiconductor manufacturing line.

Claims

1. A vacuum processing apparatus composed of a cassette block and a vacuum processing block. said cassette block having a cassette table for mounting a plurality of cassettes. each containing a sample, said vacuum processing block having a plurality of processing chambers treating said sample and vacuum transfer means for transferring said sample. wherein

   both of the plan shapes of said cassette block and said vacuum processing block are nearly rectangular and the relation $W_1-W_2 \geq C_w$ is satisfied. where W_1 is the width of said cassette block. W_2 is the width of said vacuum processing block. and C_w is the width of said cassette.

2. A vacuum processing apparatus composed of a cassette block and a vacuum processing block. said cassette block having a cassette table for mounting a plurality of cassettes, each containing a sample, said vacuum processing block having a plurality of processing chambers for treating said sample and vacuum transfer means for transferring said sample, wherein

   the width of said vacuum processing block is designed smaller than the width of said cassette block, and the plan view of said vacuum processing apparatus is formed in any one of an L-shape and a T-shape.

3. A vacuum processing apparatus composed of a cassette block and a vacuum processing block. said cassette block having a cassette table for mounting a plurality of cassettes each containing a sample and atmospheric transfer means for transferring said sample. said vacuum processing block having a plurality of processing chambers for performing vacuum processing to said sample. a load lock chamber on the loading side, a load lock chamber on the unloading side and vacuum transfer means for transferring said sample between said processing chamber and said load lock chambers on the loading side and the unloading side. said atmospheric transfer means transferring said sample between said cassette and said both load lock chambers, wherein

   both of the plan shapes of said cassette block and said vacuum processing block are nearly rectangular and the relation $W_1-W_2 \geq C_w$ is satisfied, where W_1 is the width of said cassette block, W_2 is the width of said vacuum processing block. and C_w is the width of one cassette.

4. A vacuum processing apparatus composed of a cassette block and a vacuum processing block. said cassette block having a cassette table for mounting a plurality of cassettes each containing a sample and atmospheric transfer means for transferring said sample, said vacuum processing block having a plurality of processing chambers for performing vacuum processing to said sample. a load lock chamber on the loading side. a load lock chamber on the unloading side and vacuum transfer means for transferring said sample between said processing chamber and said load lock chambers on the loading side and the unloading, said atmospheric transfer means transferring said sample between said cassette and said both load lock chambers. wherein

   both of the plan shapes of said cassette block and said vacuum processing block are nearly rectangular and the width of said vacuum processing block is designed smaller than the width of said cassette block. and the plan view of said vacuum processing apparatus is formed in any one of an L-shape and a T-shape.

5. A vacuum processing apparatus composed of a cassette block. a vacuum processing block and atmospheric transfer means for transferring a sample between both blocks, said cassette block having a cassette table for mounting a plurality of cassettes each containing said sample, said vacuum processing block having a plurality of processing chambers for performing vacuum processing to said sample, a load lock chamber on the loading side, a load lock chamber on the unloading side and vacuum transfer means for transferring said sample between vacuum transfer means for transferring said sample between said processing chamber and said load lock chambers on the loading side and the unloading, said atmospheric transfer means transferring said sample between said cassette and said both load lock chambers. wherein

both of the plan shapes of said cassette block and said vacuum processing block are nearly rectangular and the relation W_1-W_2≥C_w is satisfied, where W_1 is the width of said cassette block, W_2 is the width of said vacuum processing block, and C_w is the width of one cassette.

6. A vacuum processing apparatus according to any one of claim 1 to claim 5, wherein

both of the plan shapes of said cassette block and said vacuum processing block are nearly rectangular and the relations W_1>W_2 and G_1<G_2 are satisfied, and W_1-W_2=Ms is used as a maintenance space, where W_1 is the width of said cassette block, W_2 is the width of said vacuum processing block, G_1 is a gap between the cassette blocks adjacent to each other, and G_2 is a gap between the vacuum processing blocks adjacent to each other.

7. A vacuum processing apparatus composed of a cassette block and a vacuum processing block, said cassette block having a cassette table for mounting a plurality of cassettes each containing a sample and atmospheric transfer means for transferring said sample, said vacuum processing block having a plurality of processing chambers for performing vacuum processing to said sample, a load lock chamber on the loading side, a load-lock chamber on the unloading side and vacuum transfer means for transferring said sample between said processing chamber and said load lock chambers on the loading side and the unloading, said atmospheric transfer means transferring said sample between said cassette and said both load lock chambers, wherein

both of the plan shapes of said cassette block and said vacuum processing block are nearly rectangular and the relations W_1-W_2≥C_w and G_1<G_2 are satisfied where W_1 is the width of said cassette block, W_2 is the width of said vacuum processing block, G_1 is a gap between the cassette blocks adjacent to each other, G_2 is a gap between the vacuum processing blocks adjacent to each other and C_w is the width of one cassette.

8. A vacuum processing apparatus according to claim 7, wherein the relationships W_1≥2d and W_1-W_2≥d are satisfied where d is the maximum diameter of a sample to be processed.

9. A vacuum processing apparatus according to any one of claim 1 to claim 8, wherein said cassette block is designed to contain a sample having a diameter not less than 300mm.

10. A vacuum processing apparatus composed of a cassette block and a vacuum processing block, said cassette block having a cassette table for mounting a plurality of cassettes each containing a sample, said vacuum processing block having an etching processing apparatus for performing etching processing to said sample and vacuum transfer means for transferring said sample, wherein

both of the plan views of said cassette block and said vacuum processing block are nearly rectangular and the relation W_1-W_2≥C_w is satisfied, where W_1 is the width of said cassette block, W_2 is the width of said vacuum processing block, and C_w is the width of one cassette.

11. A semiconductor manufacturing line comprising a plurality of bay areas where a plurality of vacuum processing apparatuses composed of a cassette block and a vacuum processing block are arranged in order of manufacturing process, said cassette block having a cassette table for mounting a cassette containing a sample, said vacuum processing block having a plurality of processing chambers for performing vacuum processing to said sample and vacuum transfer means for transferring said sample, wherein

at least one of said vacuum processing apparatuses is designed so that said cassette block is capable of containing a sample having a diameter not less than 300 mm and the relation W_1-W_2≥C_w is satisfied, where W_1 is the width of said cassette block, W_2 is the width of said vacuum processing block, and C_w is the width of one cassette.

12. A semiconductor manufacturing line according to claim 11, wherein each of said bay areas has a stoker, said sample being transferred along the manufacturing line and to the stoker in each of the bay areas using an automatic line transfer machine, said sample being transferred between said stoker of each bay area using an automatic bay transfer machine.

13. A method of constructing a semiconductor manufacturing line comprising a plurality of vacuum processing apparatuses composed of a cassette block capable of containing a sample having a diameter not less than 300 mm, and a vacuum processing block for performing vacuum processing to said sample, wherein

at least one of said vacuum processing apparatuses is designed so that the width of said cassette block is larger than the width of said vacuum processing block and the plan view of said vacuum processing apparatus is formed in any one of an L-shape and a T-shape, and

a maintenance space is provided between said any one of L-shaped and T-shaped vacuum processing apparatuses and the adjacent vacuum processing apparatus.

14. A method of constructing a semiconductor manufacturing line according to claim 13, wherein a plurality of bay areas having a plurality of said vacuum processing apparatuses arranged in order, according to the semiconductor manufacturing process, a line automatic transfer machine and in-bay automatic transfer machines being provided. each of the bay areas having a stoker, said sample being transferred along the manufacturing line and to the stoker in each of the bay areas using an automatic line transfer machine, insaid said bay area, an automatic in-bay transfer machine transfers said samples between said stoker and said processing apparatuses.

15. A method of constructing a semiconductor manufacturing line according to any one of claim 13 and claim 14. wherein said vacuum processing apparatus contains an etching processing apparatus for performing etching process to said sample.

FIG. 1

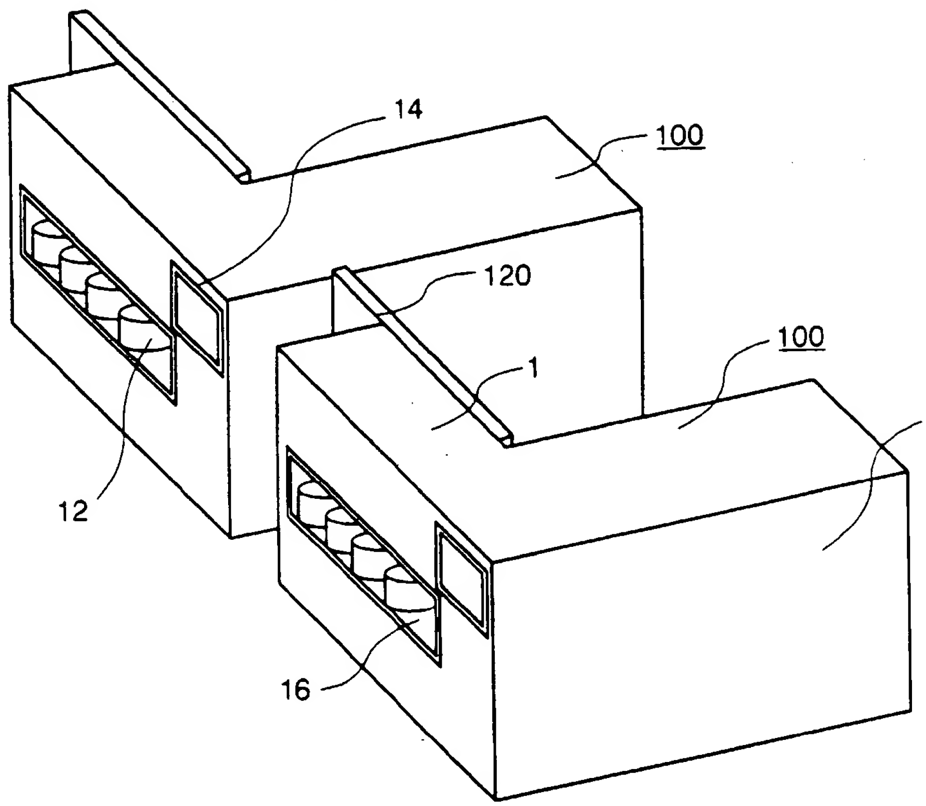


FIG. 2

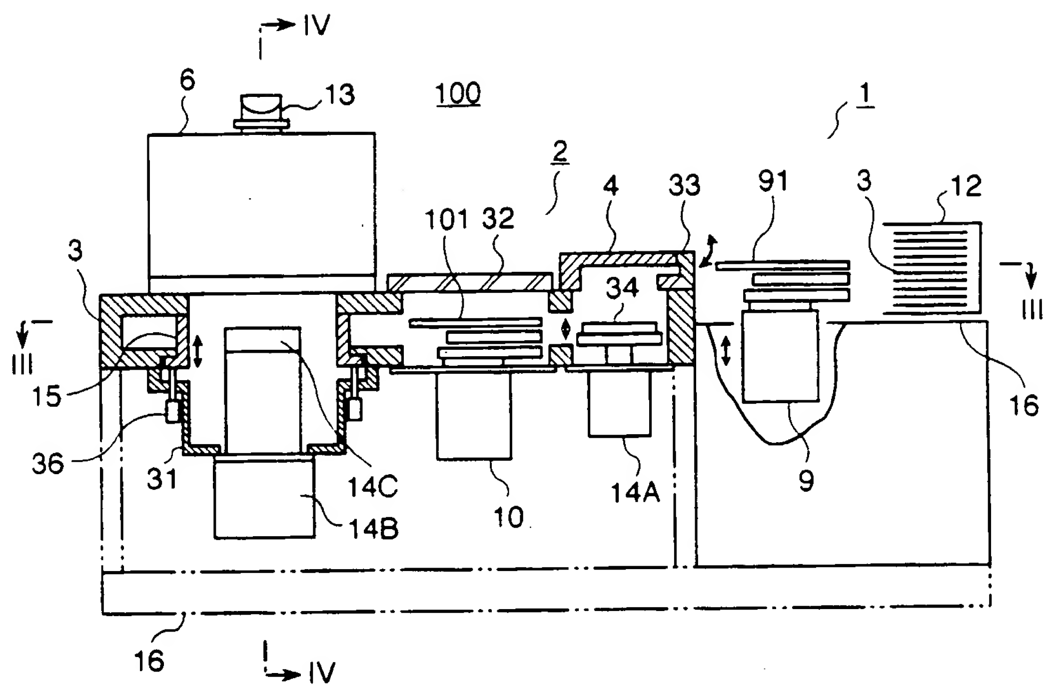

IV
6
13
100
1
2
4
33
91
3
12
101
32
34
3
III
III
15
16
36
31
14C
14B
10
14A
9
16
IV

FIG. 3

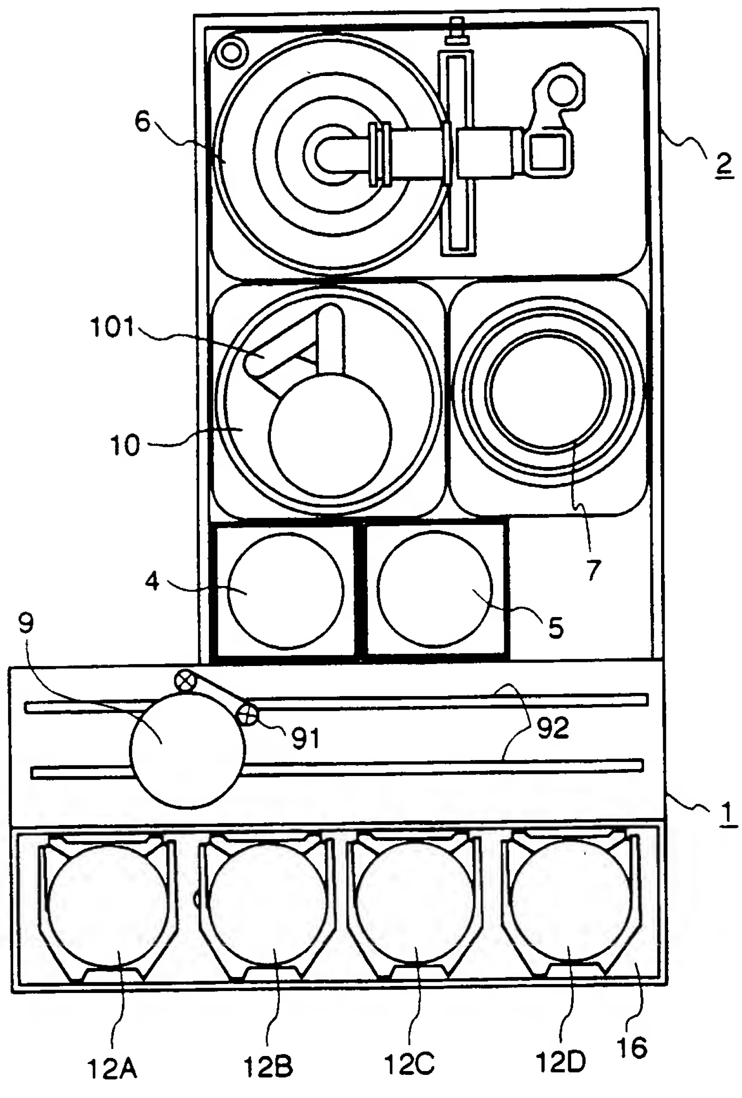


FIG. 4

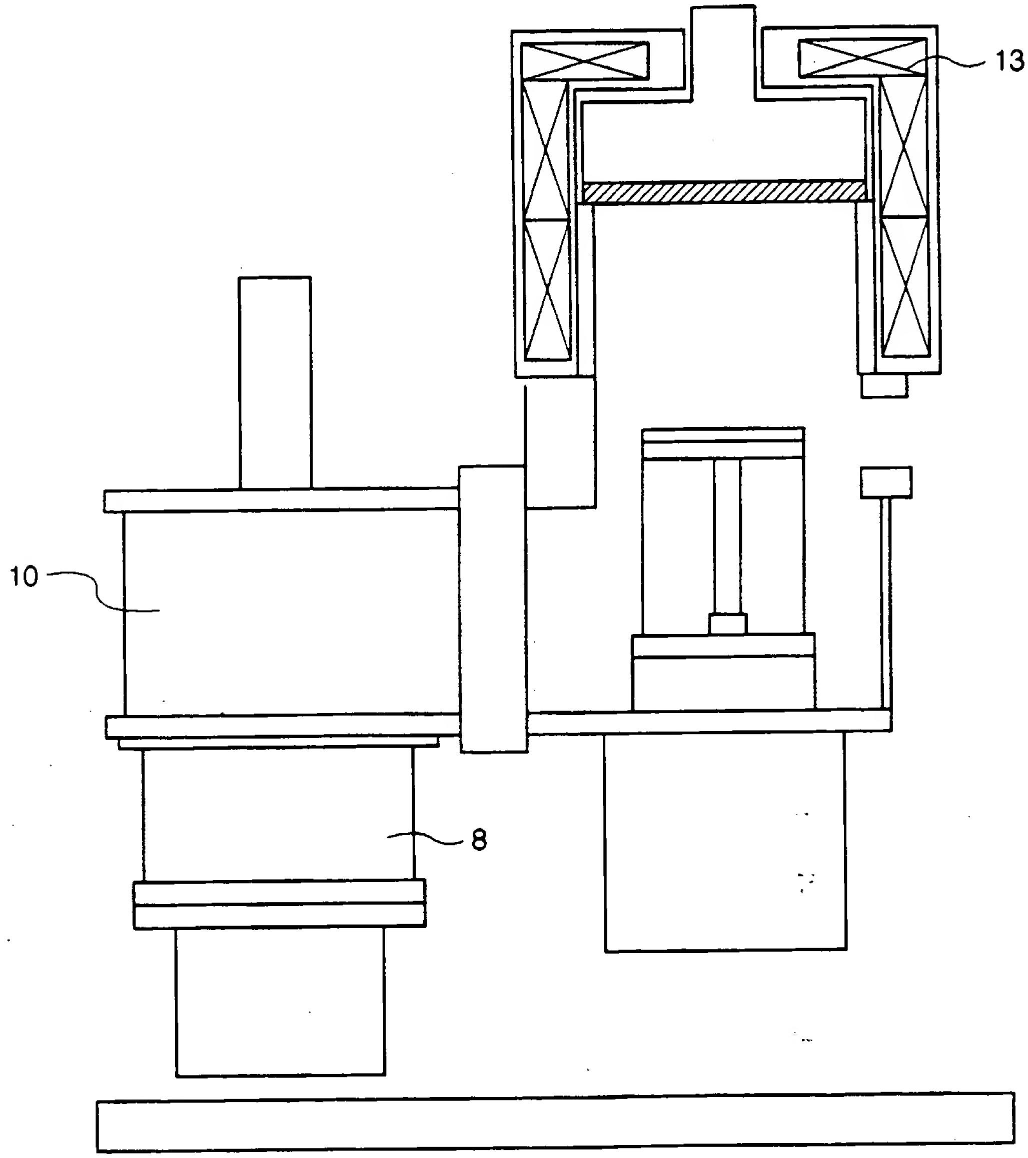


FIG. 5

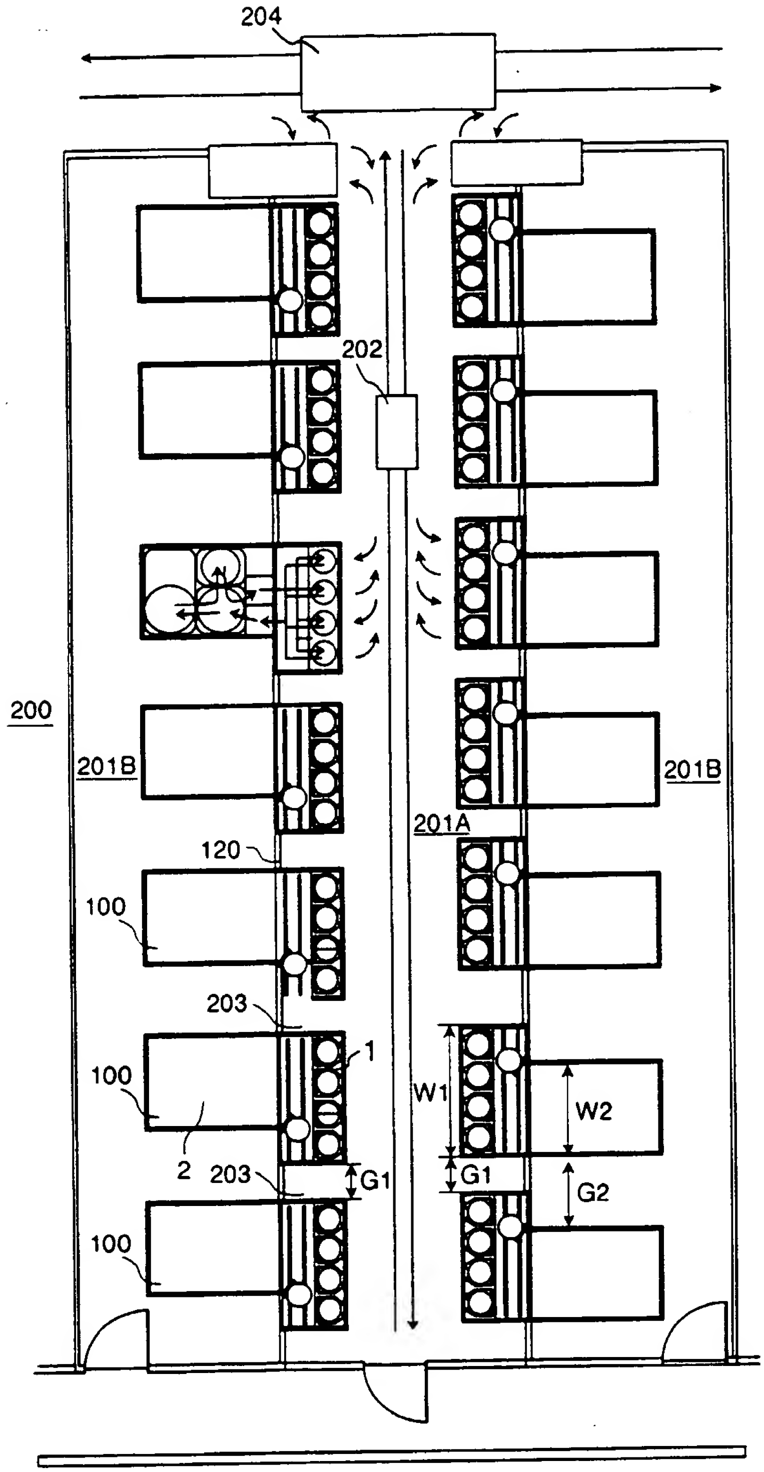

204
202
200
201B
201B
201A
120
100
203
1
100
2
203
G1
W1
W2
G1
G2
100

FIG. 6

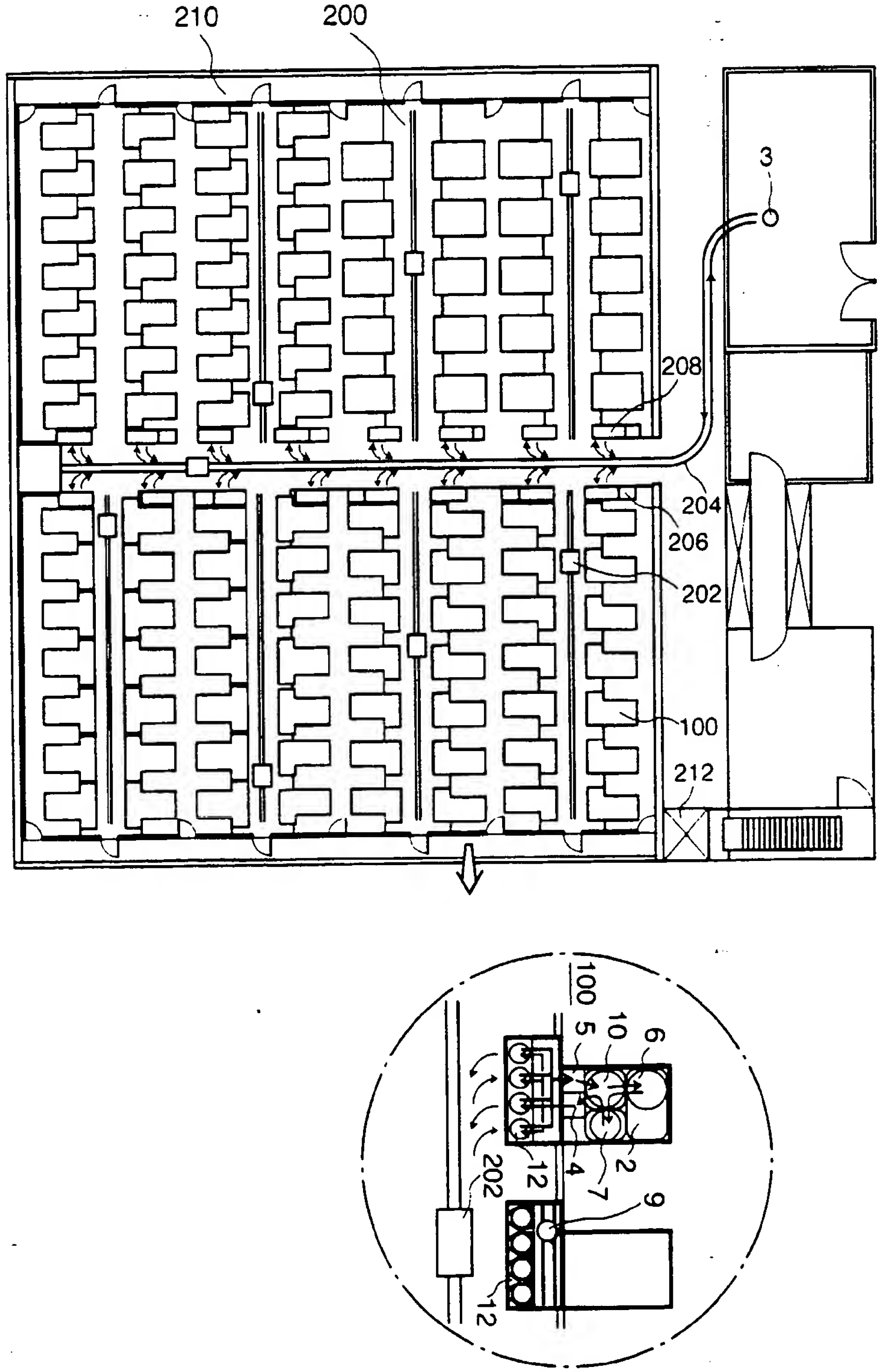


FIG. 7

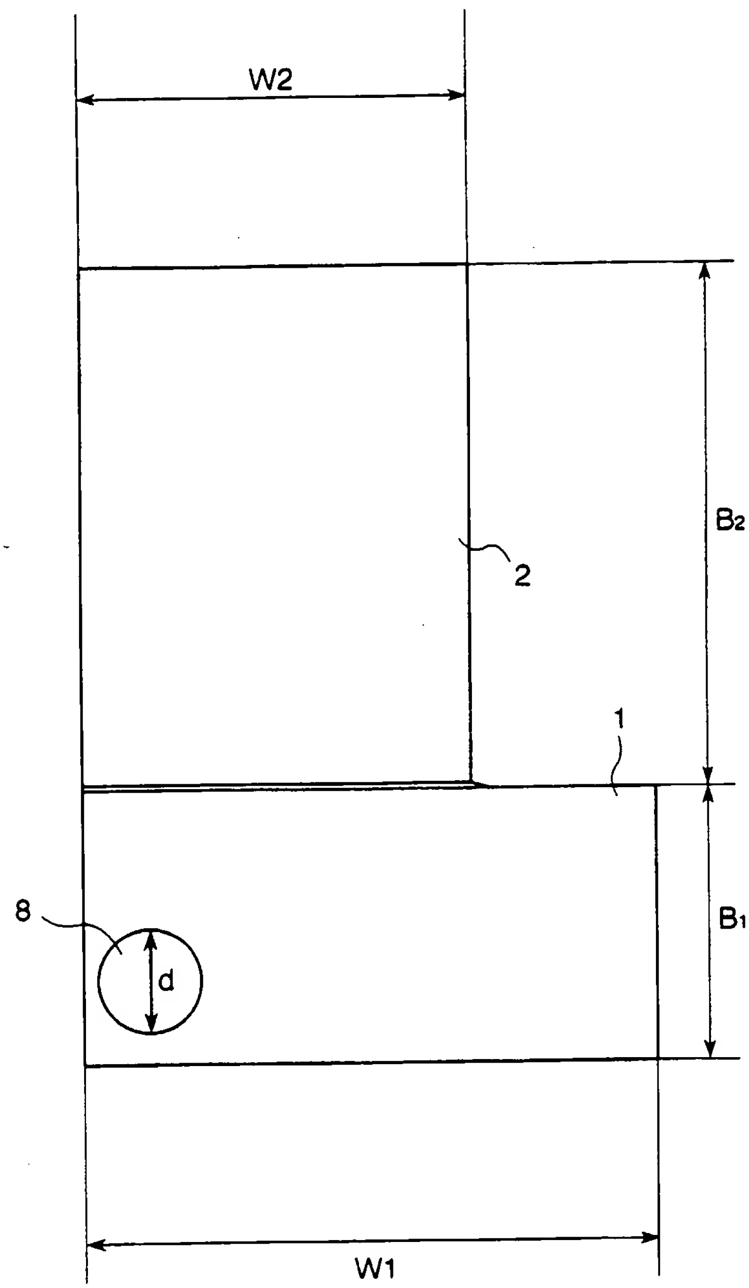


FIG. 8

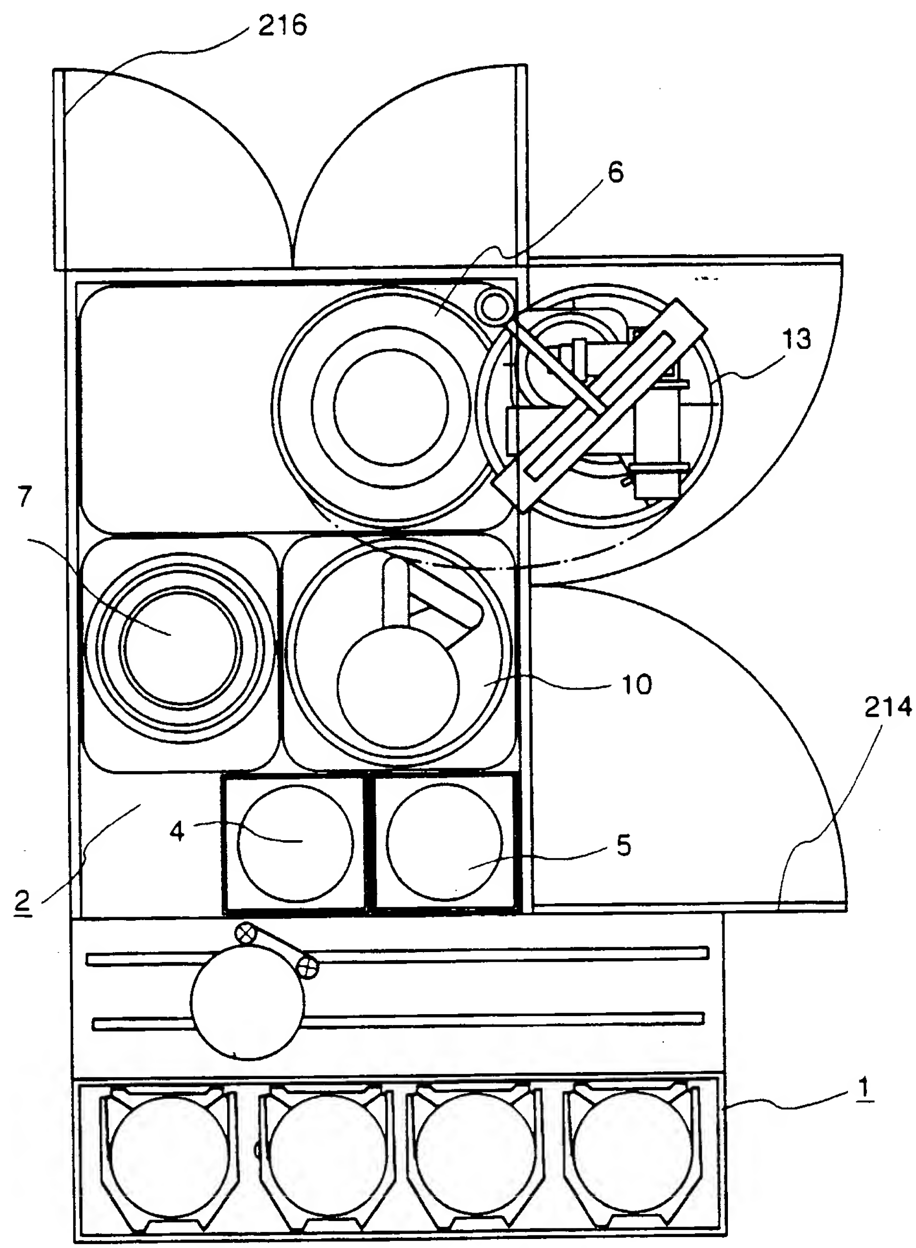


FIG. 9

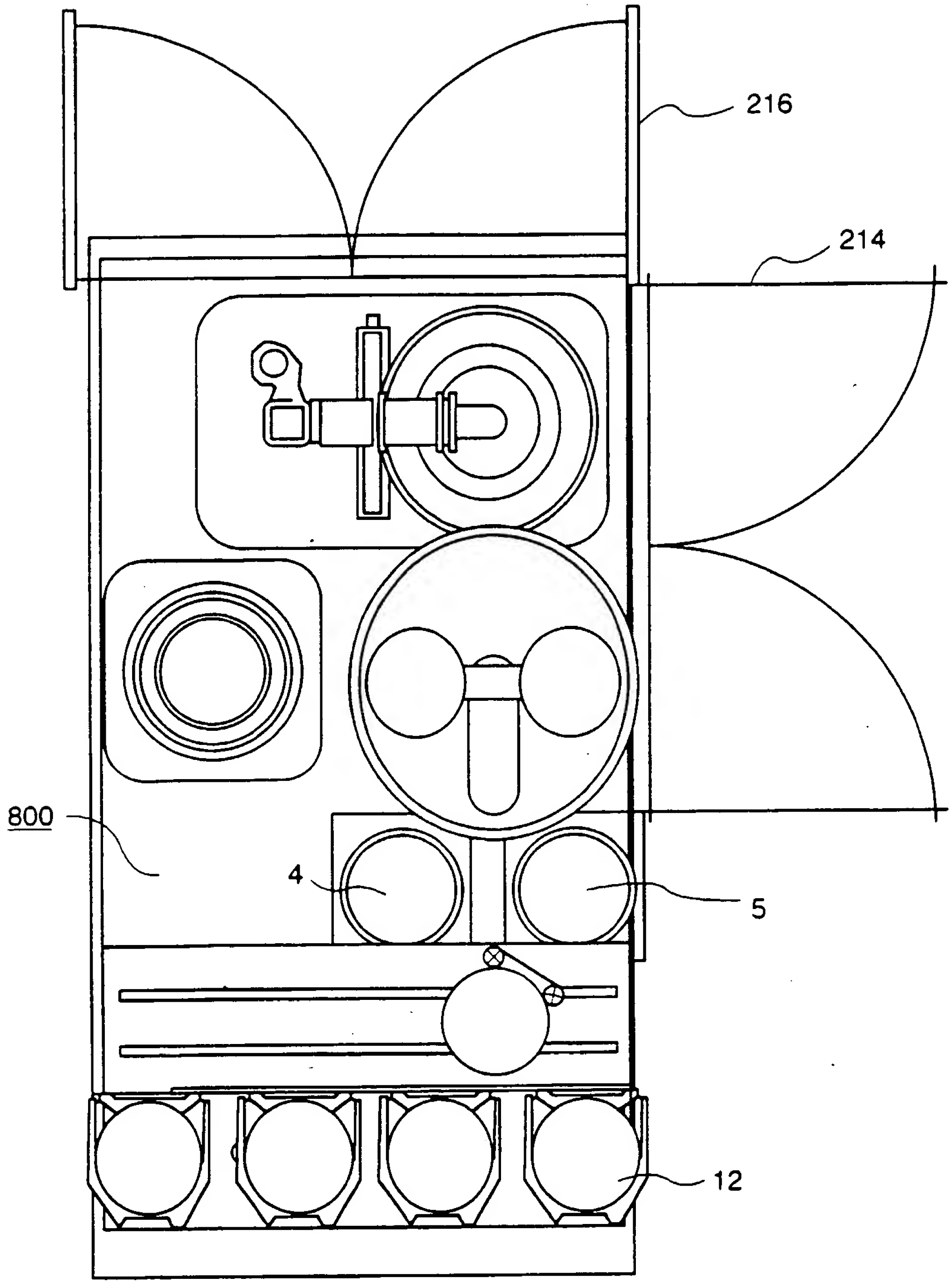


FIG. 10

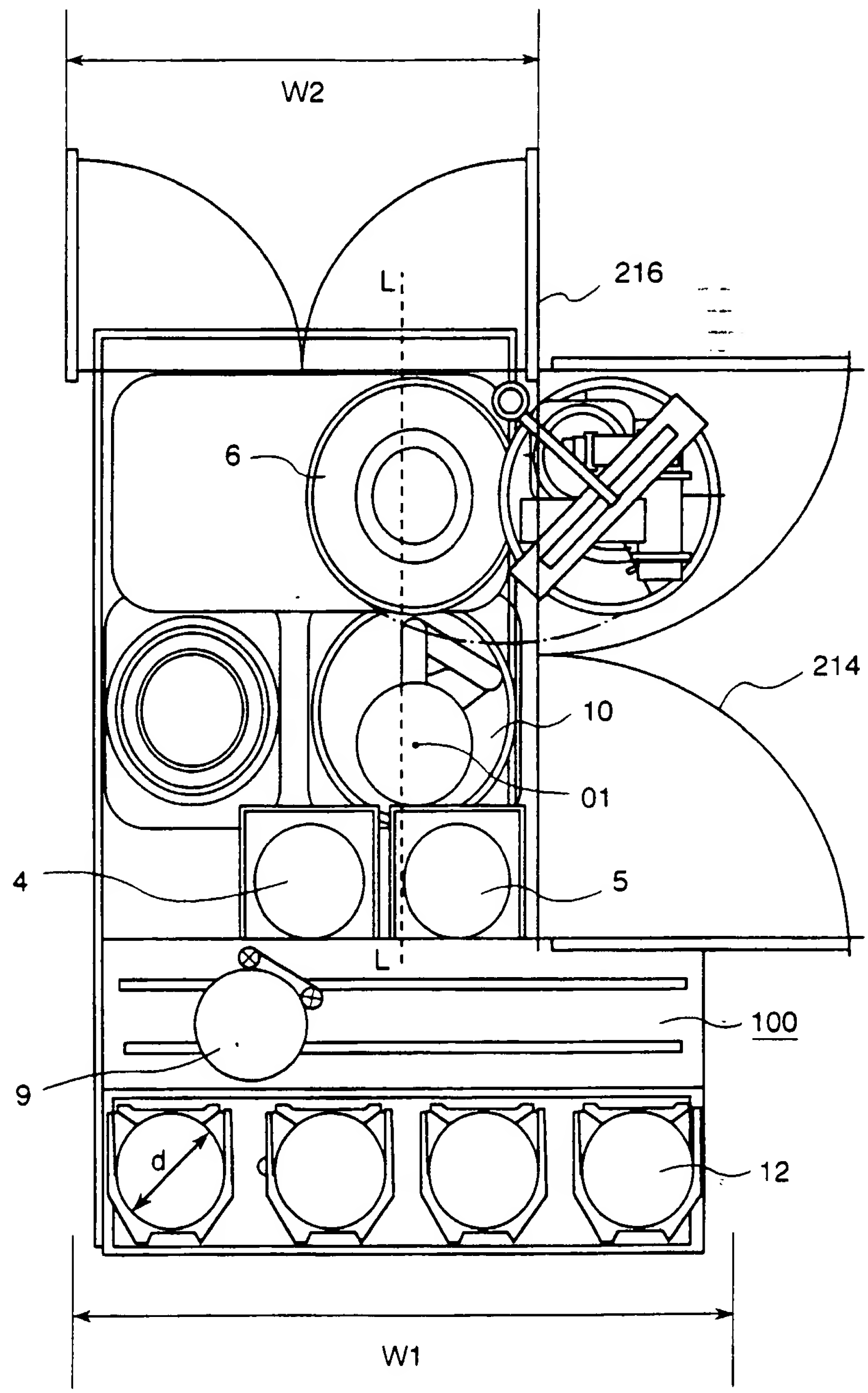


FIG. 11

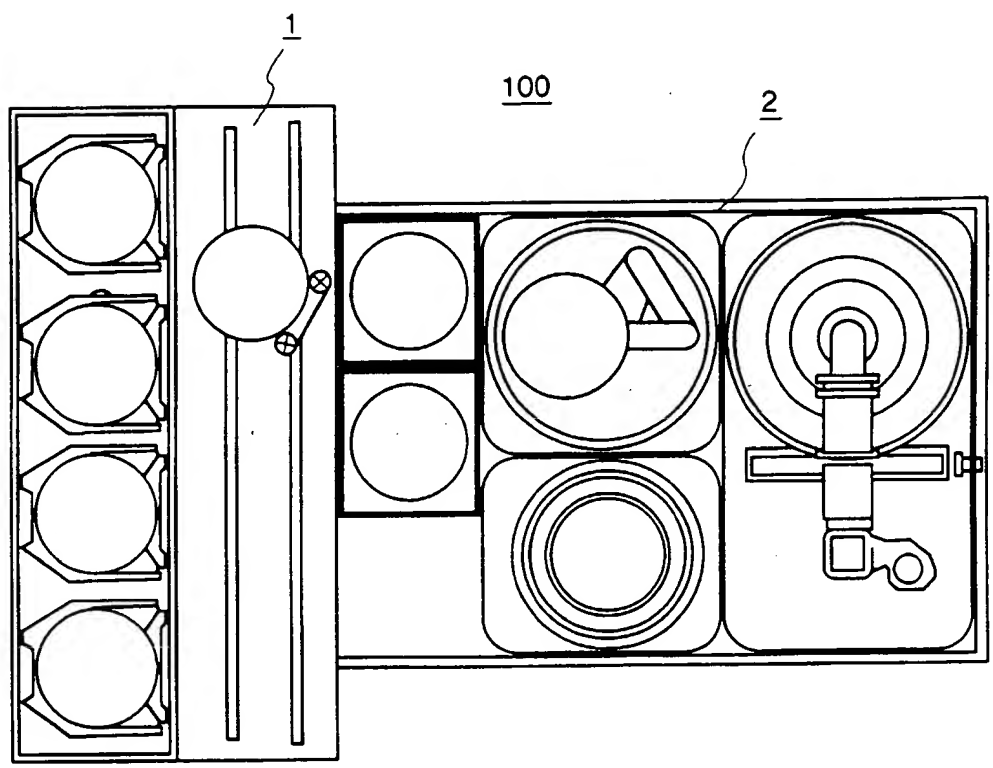


FIG. 12

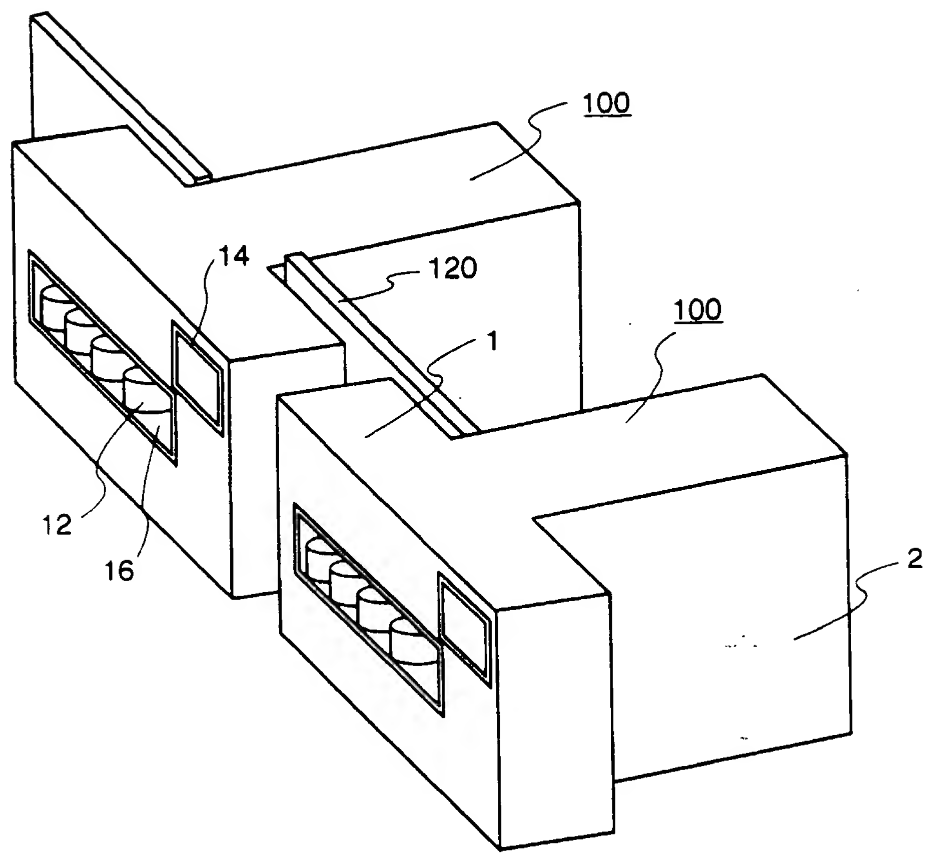


FIG. 13

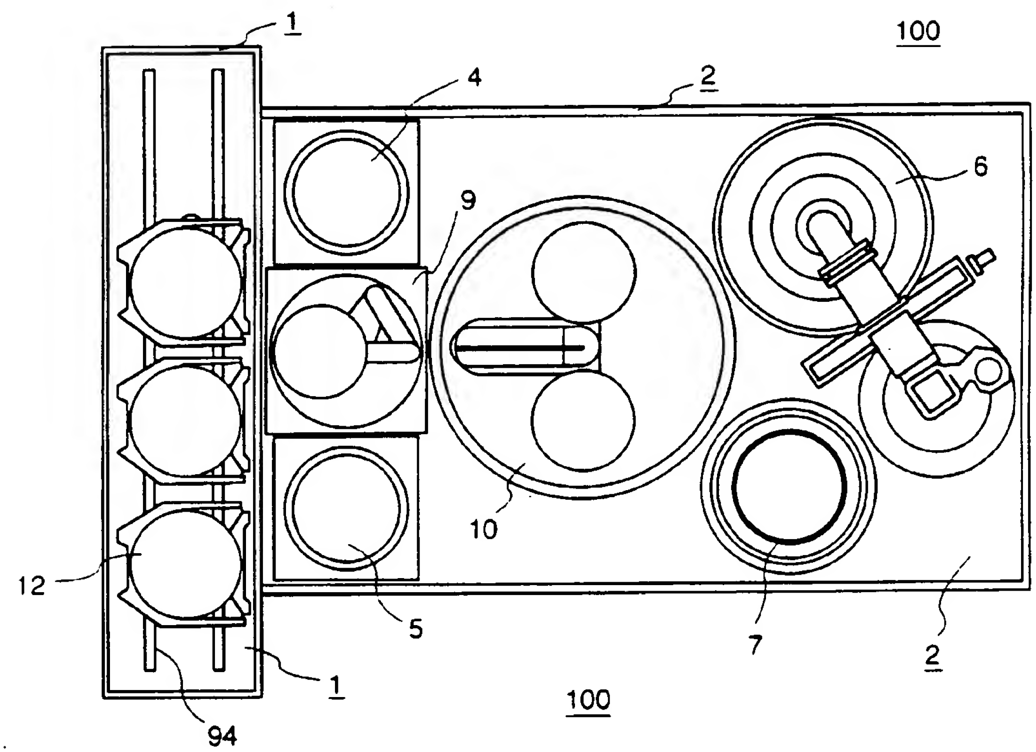


FIG. 14

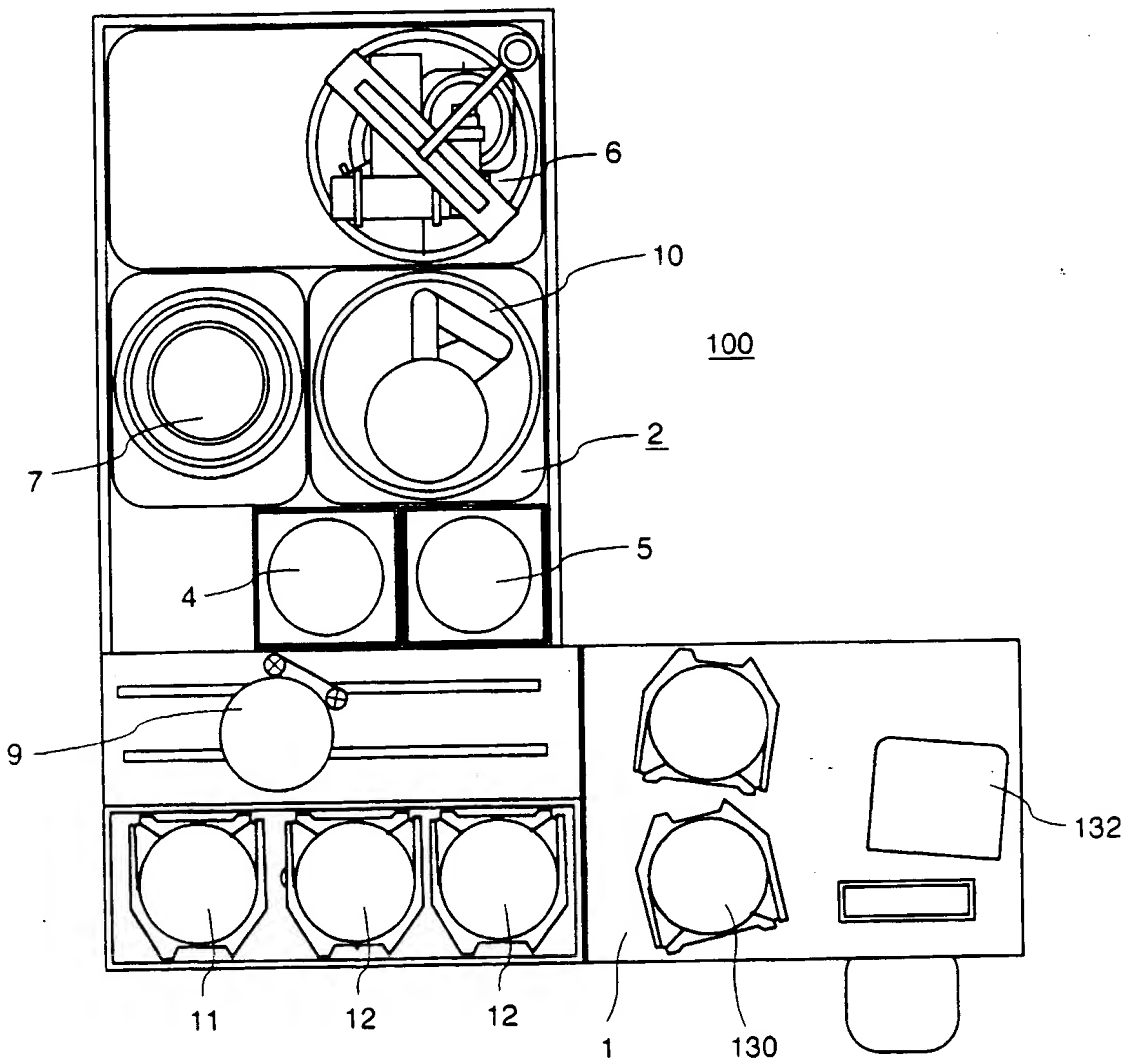


FIG. 15

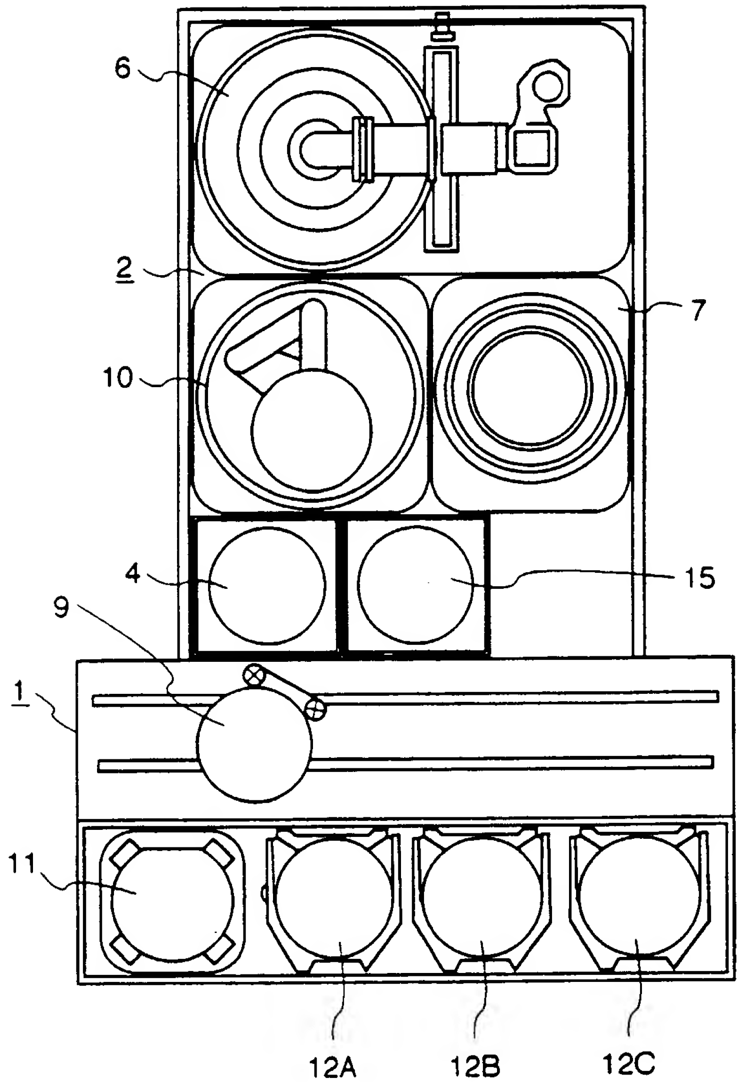


FIG. 16

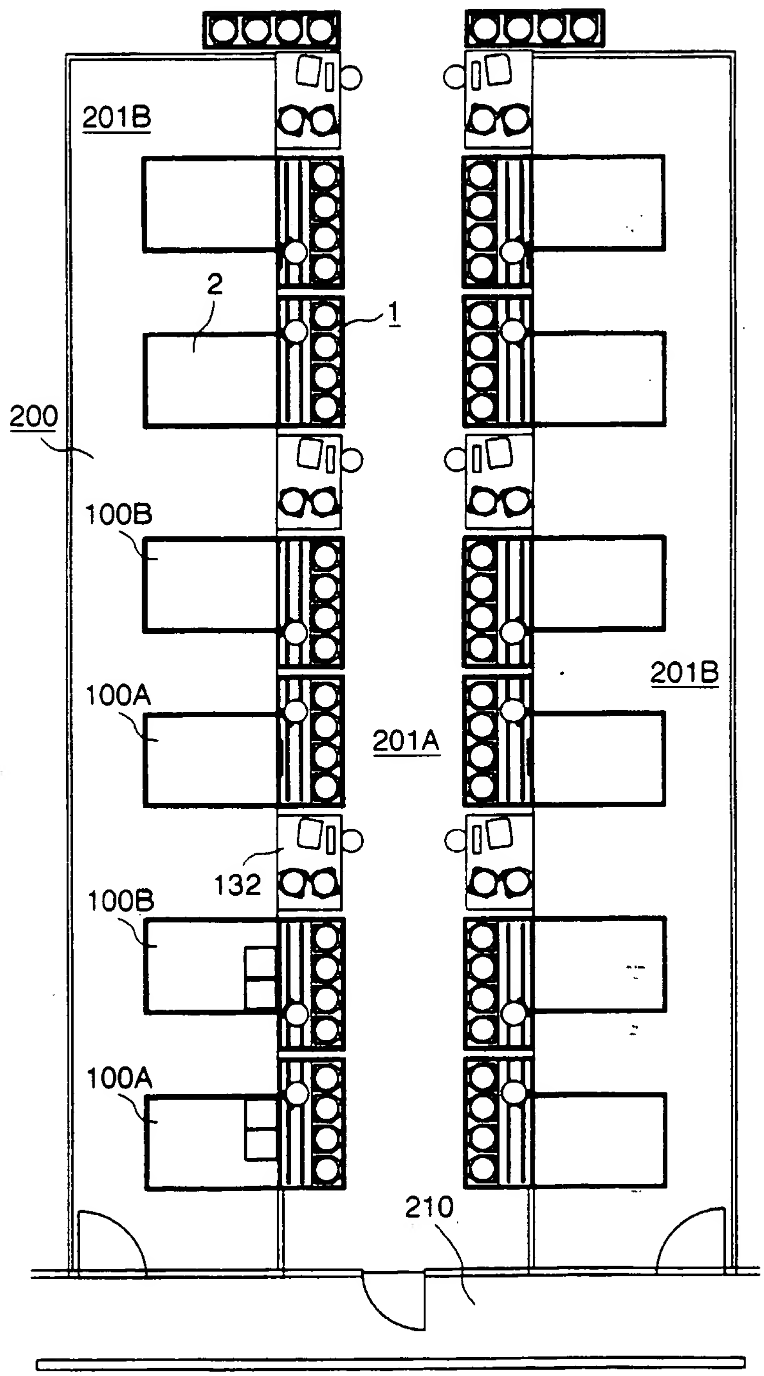


FIG. 17

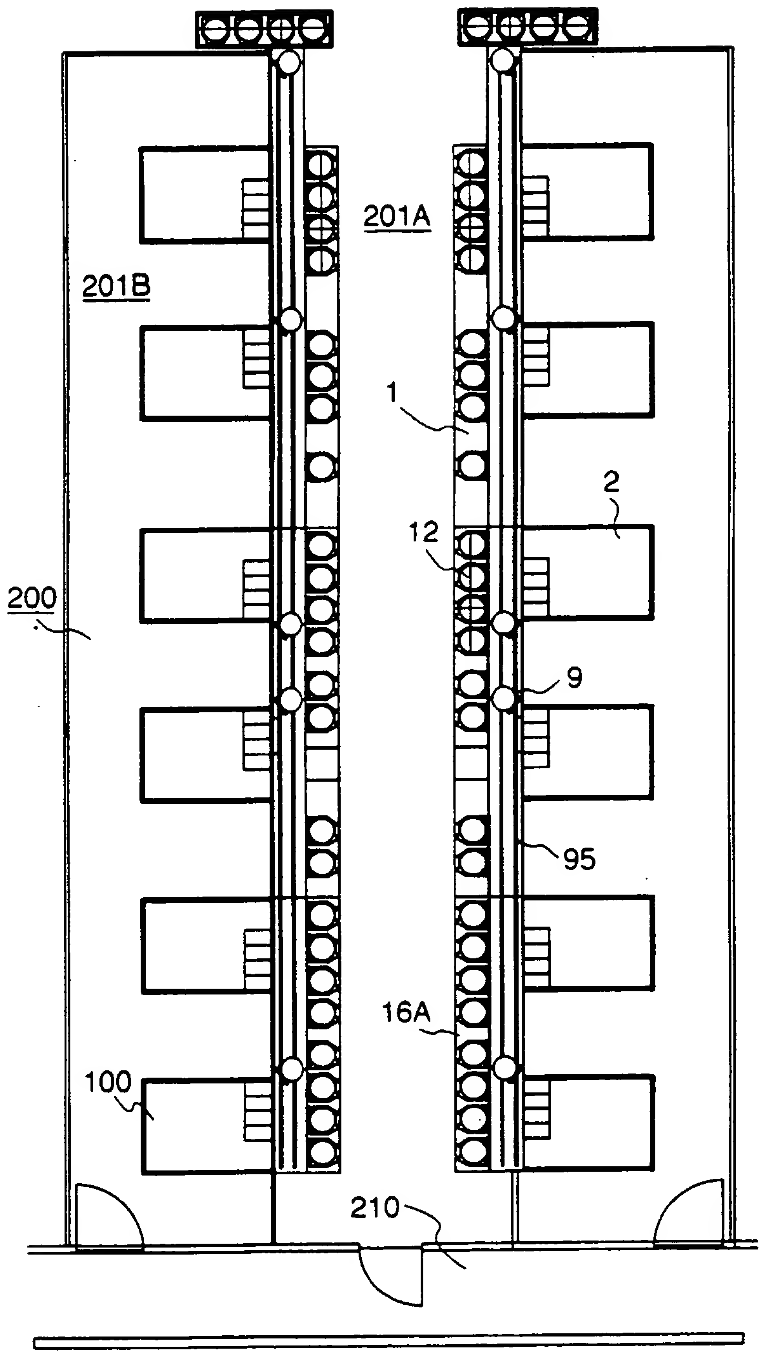


FIG. 18

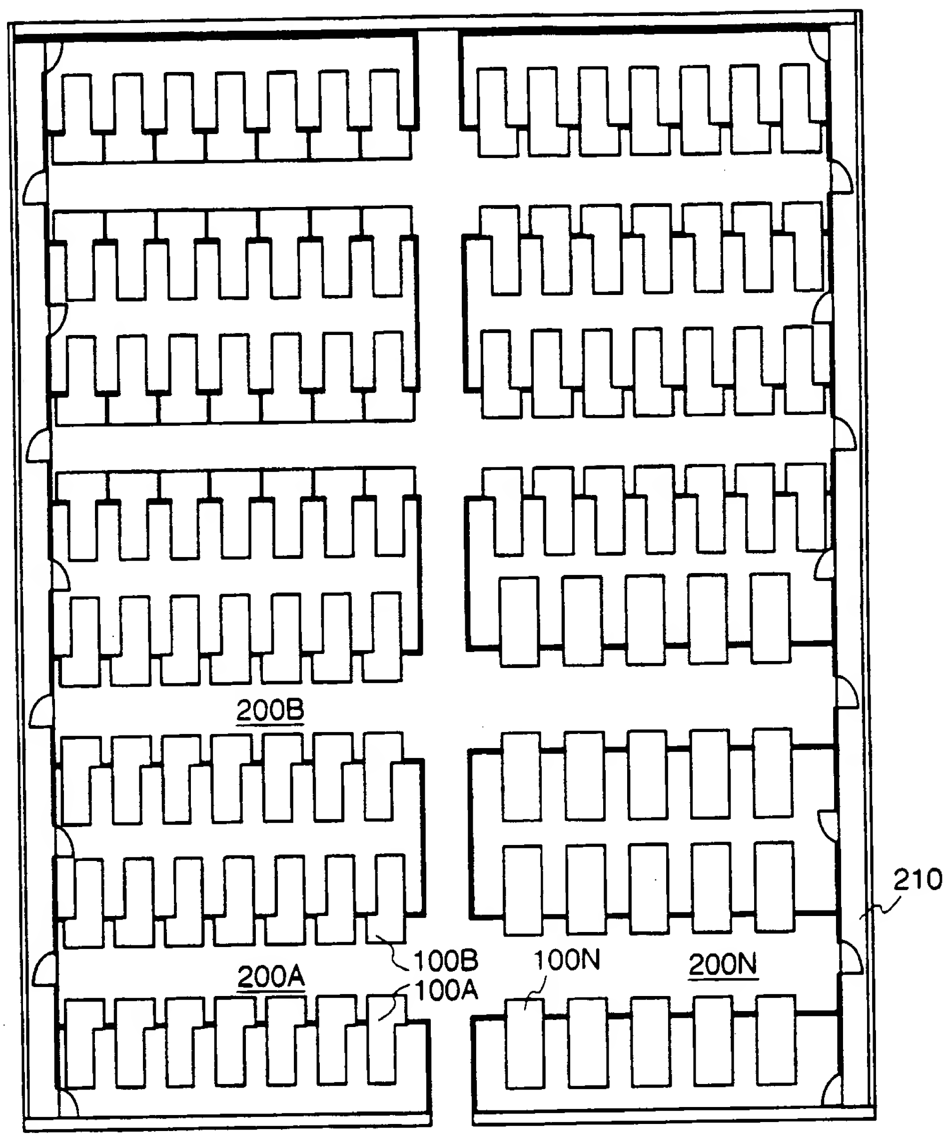


FIG. 19

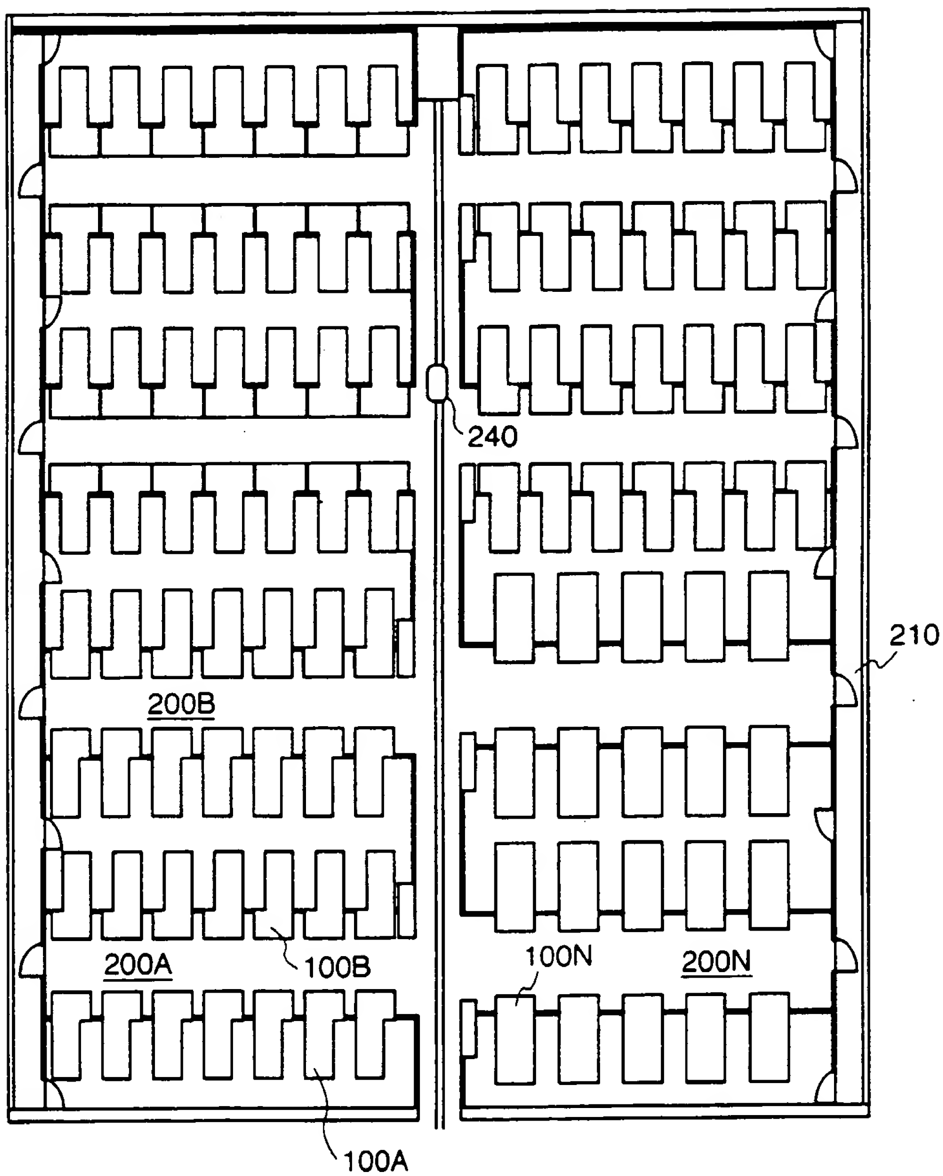


FIG. 20

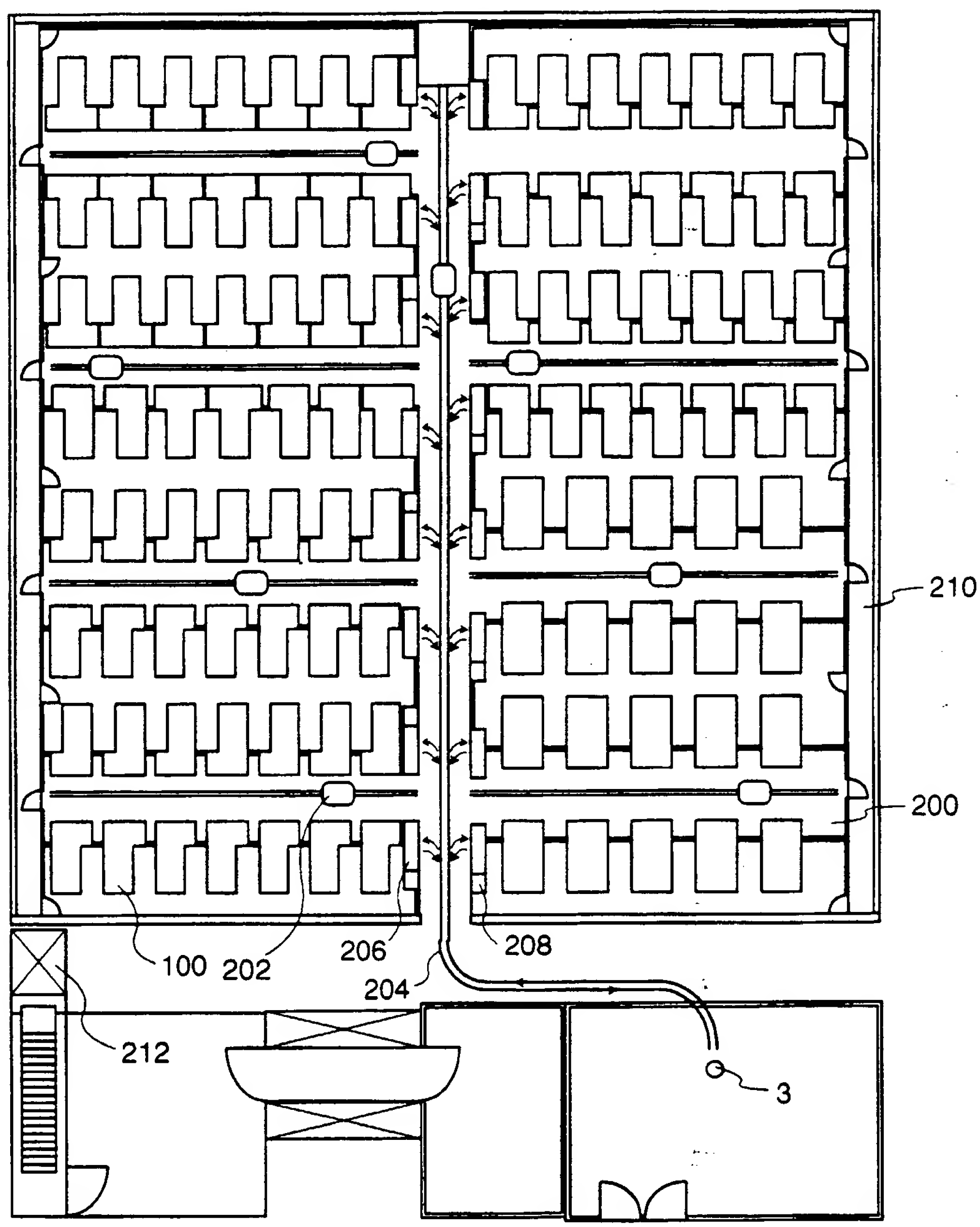


FIG. 21

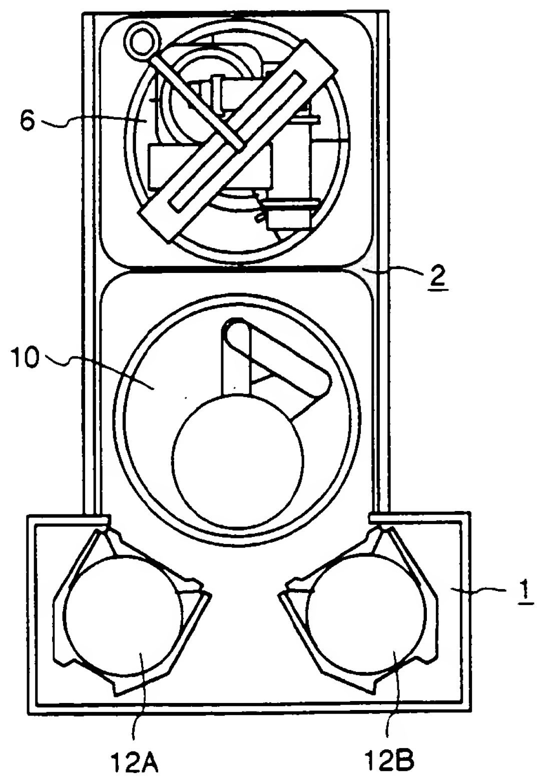
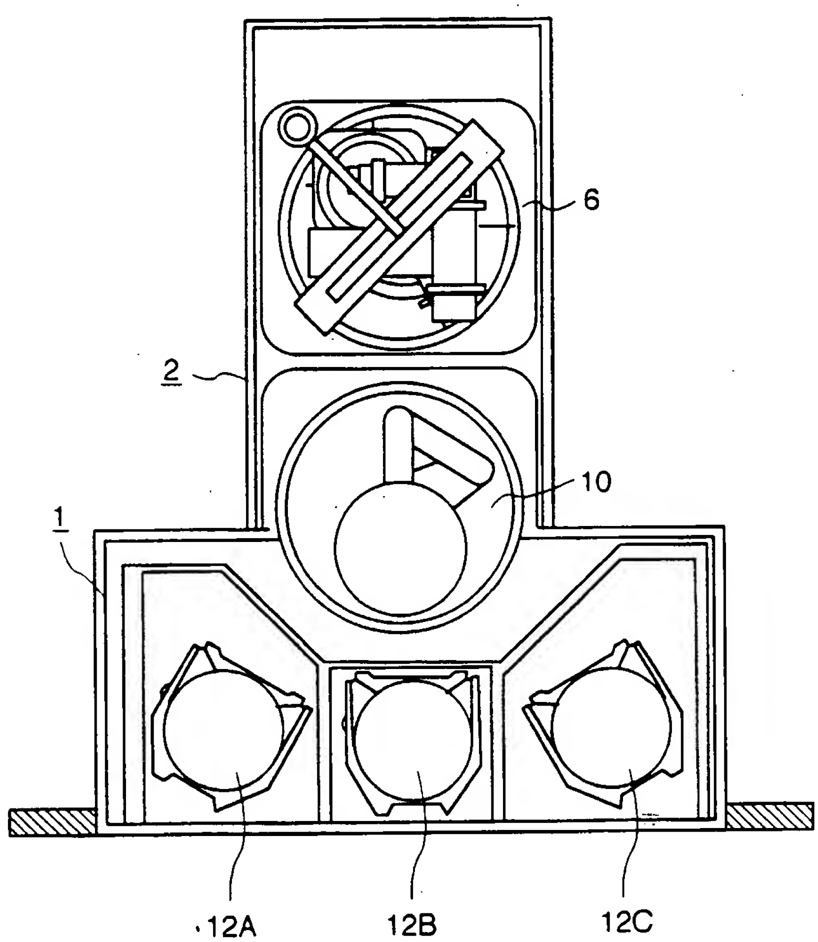


FIG. 22



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 96 30 5154

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	IBM TECHNICAL DISCLOSURE BULLETIN, vol. 27, no. 12, 31 May 1985, pages 6997-6998, XP002017023 "generic work station" * the whole document *	1-7	H01L21/00
A	EP-A-0 502 412 (TOKYO ELECTRON LTD) 9 September 1992 * column 7, line 41 - column 9, line 26; figure 1 *	1-7	
A	GB-A-2 056 169 (HITACHI) 11 March 1981 * the whole document *	11	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)
H01L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	29 October 1996	Bolder, G

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)